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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

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COLOR MUTATION IN A TULIP

(See Page 452)

Blood Groups and Heredity

Quenching the Life of the Farm

Bud Mutations in the Orange

Hairless Rabbits

OCTOBER, 1928 Vol. 19, No. 10

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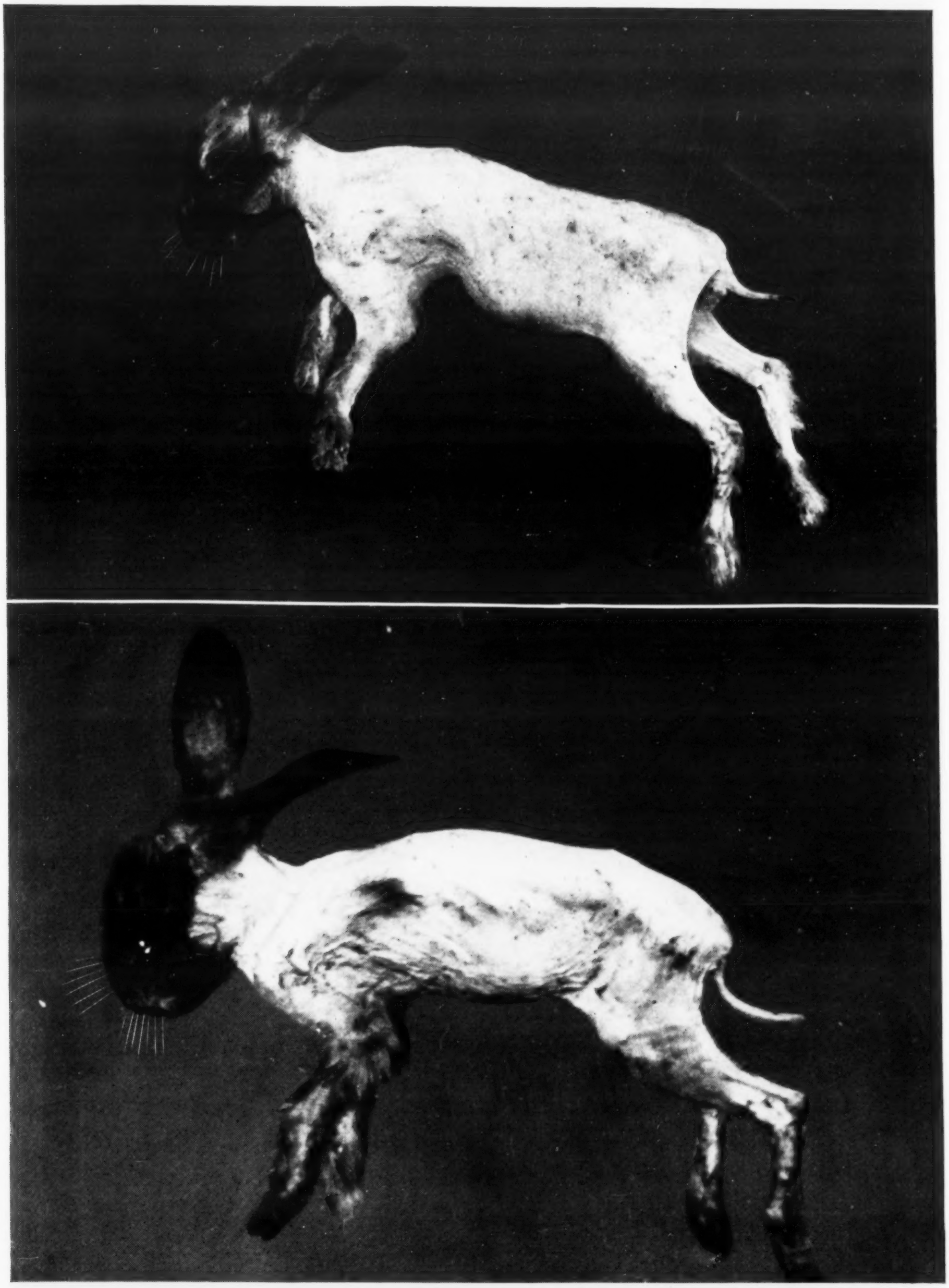

A HAIRLESS "INHAIRITANCE"

Frontispiece

Hairlessness has been noted as an inherited character in a number of species of mammals. In rabbits the defect appears to be inherited as a Mendelian recessive, at least in the research here reported. Defects in the teeth also characterise the condition and none of the hairless rabbits lived more than a month. (See "Naked—A Recessive Mutation in the Rabbit," page 439.)

THE BLOOD GROUPS IN HEREDITY

A Review

IF one pours a little human blood into a test tube and lets it stand for a while, the red blood corpuscles settle to the bottom, leaving a clear serum. If the tube is shaken, these red cells will move evenly through all parts of it, making a smooth emulsion.

Now add a few drops of blood from another person, and no visible effect may be produced. On the other hand, the red blood cells of the first specimen may suddenly lump together and fall to the bottom of the tube.

Evidently different bloods have different effects on a given specimen, and the problem is not only one of abstract interest, but one of life and death in a case of blood transfusion, since the introduction into a sick man of some one else's blood may finish him off altogether, if it happens to clot his own blood.

As a result of more than a quarter of a century of work, since K. Landsteiner first described the facts accurately in 1901, the isoagglutination of the blood has been examined from almost every point of view; and today there is perhaps no single field in which so much active work is being done. The relative simplicity of the technique, the great precision of the results, and the wide variety of practical and theoretical consequences, combine to make this field particulaly attractive.

One of the pioneers and most prolific students is Ludwig Hirszfeld, who started with von Dungern at Heidelberg, but is at present vice-director of the National Hygienic Institute at Warsaw. He has now summarized what is known of the genetics of the blood groups in a book* that must for some time be a standard work of reference for those engaged in this field, since he not only cites the work of almost every author, but cites it critically, prints the original data in full, and has in many instances corrected or completed these original data by correspondence with the author.

The Two Constituents

To abbreviate a long story, two different substances (agglutinogens) have been found in the red blood cells, which cause these cells to ball together into shapeless, tough, little masses when exposed to certain other substances (agglutinins) in the blood serum.

For convenience, the agglutinogens in the cells may be called *A* and *B*. If one's cells do not possess *A*, one's serum will possess an agglutinin (*a* or anti-*A*) which coagulates *A*. This is simply to say that one's blood can not possess both *A* and anti-*A*, or it would agglutinate itself. It is protected from this catastrophe by nature, just as the stomach is protected from digesting itself.

Either the agglutinogen *A* in the red cells or the agglutinin *a* in the serum might with equal propriety be designated as the inherited entity, but convention has fixed on *A*, so that *a* merely figures, usually, as the absence of *A*. The second pair, *B* and *b*, behaves independently in the same way.

The cells may contain neither, either one, or both of the agglutinogens, giving rise to four types of blood, with an equal number of complementary types of serum. The physiological differences of these four types are shown most conveniently in tabular form (Table I), from which it will also be apparent that only certain combinations between them can be made with safety.

*Hirszfeld, Ludwig. Konstitutionsserologie und Blutgruppenforschung. Pp. 235 with 12 illus., price M.18. Verlagsbuchhandlung Julius Springer, Berlin W 9, Linksstrasse 23-24, Germany. 1928.

Hence, when a blood transfusion is required in a hospital, the first thing the doctor does is to test the blood offered by various donors, to see if it can be used safely. More commercially, he need only test the blood of his patient, and then from his card index of vendors pick out the one who offers the right specifications, and who is willing to open his arteries at $25 per quart or whatever the market price may be.

Reuben Ottenberg pointed out as early as 1908 that this peculiarity of the blood seemed to be inherited in Mendelian fashion, and in 1910 von Dungern and Hirszfeld proposed a scheme of two independent genes with their allelomorphs to account for the observed facts of heredity. A few years ago (1924-25) F. Bernstein in Germany and T. Furuhate in Japan independently came to the conclusion that the facts were explained better by combinations of three multiple allelomorphs.

Three Allelomorphs

The nomenclature of the subject has been badly spoiled by too many cooks, but the underlying facts are simple. It is supposed that there was originally a recessive gene, *O*, related to the agglutinibility of the red corpuscles. In due time this gave rise to a dominant mutation *A*, and later to another dominant mutation *B*. These three genes, *O*, *A*, and *B*, then, occupy the same locus in a chromosome, and the individual can possess any combination of two of them. Without going into detail, the most generally accepted scheme names the groups as follows:

Group	*Genes*
I	*OO*
II	*AA* or *AO*
III	*BB* or *BO*
IV	*AB*

Since *A* and *B* are both dominant to *O*, it is evident that *AA* and *AO* will behave just alike, so that either combination results in Group II; and a similar explanation applies to *BB* and *BO* in group III.

How closely do the facts fit the Mendelian scheme? Dr. Hirszfeld cites studies of over 5,000 children and their parents, in which only 36 (0.6%) are unconformable. When one considers the probability not only of occasional faulty technique, but of illegitimacy, which would produce a child that did not fit the expectations from its putative parents, this is an extraordinarily close agreement, and makes it unnecessary to invoke any other explanations that might be quite justifiable, such as mutation, failure of dominance, or change during the lifetime of an individual. On the last point, there is agreement that the blood grouping is remarkably constant, but it is apparently possible for it to change with bacterial action, so it is not inconceivable that disease might change it.

TABLE I—Characteristics of Blood Groups

Group	*Red cells*	*Serum*
I	Inagglutinable. Contains no agglutinogen. (Universal recipient.)	Agglutinates cells of the three other groups. Contains agglutinins *a* and *b*.
II	Agglutinated by serum of groups I and II. Contains agglutinogen *A*.	Agglutinates cells of groups III and IV. Contains agglutinin *b*.
III	Agglutinated by serum of I and II. Contains agglutinogen *B*.	Agglutinates cells of groups II and IV. Contains agglutinin *a*.
IV	Agglutinated by serum of three other groups. Contains agglutinogens *A* and *B*.	No agglutinative effect. Contains no agglutinins. (Universal donor.)

The agglutinogens of the red cells are ordinarily present in the fetus not only at birth, but several months before. (They may also be demonstrated a long time after death.) Agglutinins of the serum are also found in the newborn, but within a few weeks they disappear, sometimes not to be demonstrable again until after a year or two; and when they do reappear, they are sometimes quite different from the ones found at birth! The conclusion is that the agglutinins may pass through the placenta, just as diphtheria antitoxin does, and that the agglutinins of the newborn are not his own but are his mother's. His own will develop independently, a little later.*

There is no difference in the sex distribution of any of the four types, but Dr. Hirszfeld thinks it possible that a mother is more likely to produce children of her own group, than is a father.

As indicated above, many investigators have started with the dogma that an original recessive gene has mutated twice to produce different dominants. There is no warrant whatever fo this in genetic theory: the mutation may just as well have occurred in the opposite direction. As a fact, the anthropoid apes seem to have *A* and *B*, or something similar, and these are also scattered through the lower mammals; so the indication is that one of these is the primitive type, and that the recessive is a subsequent mutation. There is no reason why the three types may not all represent various mutations occurring on many different occasions in history.

Racial Distribution

An immense amount of work has been done to determine the racial and geographical distribution of these genes. According to Dr. Hirszfeld's laborious compilation of the data, *B* increases as one goes from west to east in Eurasia, and *A* decreases, thus suggesting to him an independent origin for the two dominants. In England *B* is found in 10% of the population, in India in 50%.

Most of the great body of anthropological speculation that has been based on these blood-group studies is of no value scientifically. It includes some lucky hits: thus the gipsies in Hungary are found to have the same percentage-distribution of blood groups as the Hindus, from whom they came a thousand years ago, and not as the Germans and Magyars among whom they now live; and the Magyars themselves show a distribution similar to that of the Mongolian peoples from whom they parted 1200 years ago.

But every one of these lucky hits can be matched with an equally unlucky miss. Thus the Chinese are put closest to the Jews; while the white inhabitants of Australia are found to have the same grouping as their neighbors, the aboriginal black fellows!

If one is going to found conclusions about racial affinity on the favorable cases, what is one to do with the unfavorable ones? One investigator answered this question to his own satisfaction by pointing out that the Chinese came from Babylonia, as did the Jews also, and that they were really the same stock at the outset—prior to the unfortunate experiment of building the Tower of Babel, presumably. Most readers will deem it preferable to avoid shots at such long range, especially in the light of what is known about point mutations of genes, and think that the same mutations have occurred on various occasions in various places, and are probably still occurring from time to time.

The American Indians and Eskimos are mostly pure recessives, with some *A* but virtually no *B* at all.

Whether the fetus is harmed by having a blood grouping different from,

*Smith, Carl H. Isi-agglutinins in the blood of the newborn, with special reference to their placental transmission. *American Journal of Diseases of Children* XXXVI(1):54:69. July, 1928.

hence "incompatible" with, that of its mother has been widely discussed. There appears to be no good evidence for the supposition. Many attempts have been made to connect preponderance of some particular blood group with a particular disease, but all the associations are slight, and there is so much room for racial differences and unconscious selection of the material that no conclusions can be taken as established.

Who was the Father?

The apparently definite and clear-cut way in which these genes are distributed in heredity has caused them to be seized upon for the establishment of paternity, and there has already arisen an extensive literature on their medico-legal value. Tests of this sort, of course, can never show that a given man is the father of a given child; but they may show that he was not, or that he might have been. A number of old cases have been reopened in Europe by men who claimed that in earlier years the paternity of a child had been ascribed to them falsely, and who want the new test to acquit them.

While the law seems to hold that no man can be forced against his will to submit to the slight needle-prick of a finger, that will yield a sample of his blood, the fact that the result of a test may acquit him but can never convict him makes thoughtful men more willing to be bled than they would perhaps otherwise be.

Anyone with an elementary knowledge of genetics can figure the possible results from the various types of matings, when the three allelomorphs *O*, *A*, and *B* are in question. But inasmuch as *AA* and *AO*, for instance, are clinically indistinguishable, as also are *BB* and *BO*, it is more practical to figure the combinations by the conventional blood groups of Jansky's nomenclature, rather than by genes; thus:

I×I produces children only of group I.
I×II or II×II produces children only of I or II.
I×III or III×III produces only I or II.
II×III can produce anything.
I×IV can produce only II or III.
II×IV, III×IV, and IV×IV can produce children of II, III, or IV, but never of I. (It should be added that group IV (AB) is rare, everywhere.)

It is reported that in the run of cases brought before the courts, the decision of the blood groups proves to be final in about 15%. By way of illustration, a man repudiated the second of his wife's children, claiming that it was really the offspring of a friend, X, whom he designated. The case was referred to the laboratory, where both mother and X were found to have blood of type I, genetically *OO*. Of the mother's two children, the first was of type II, or *AO*, the second of type III, or *BO*. The recessive *O* in the children evidently could and undoubtedly did come from the mother, but whence the *A* and *B*? Evidently not from the accused X, for he possessed neither of these genes, his formula being *OO*. It was pretty clear, then, that both *A* and *B* came from the woman's husband, and that his formula was *AB* (type IV); hence that both the children were his offspring. Significantly enough, he refused to allow his own blood to be tested! But at least X was exonerated.

Sub-groups Appearing

The history of nearly all supposed "unit characters" in genetics has been that they were sooner or later broken up into smaller inherited units; and these in turn, if analysis is carried far enough, are usually in turn resolved into still smaller subdivisions as the operation of additional genes is identified. The blood groups seem not to be excepted from this custom, and subgroups, apparently characteristic of individual families, are already being brought to light. A beginning has just been made on this line of investigation, which offers promise of more definite aid in establishing paternity than do the original blood groups themselves.

Interestingly enough, the spermato-

zoa also have been found to be goup-specific, containing substances either identical with or at least similar to *A* and *B* of the red blood cells. This not only offers a means, medico-legally, for determining whether seminal stains on cloth, for instance, could or could not have been due to a given man; but to the geneticist it raises the question whether "incompatible" blood-grouping in a mating may influence the activity of the spermatozoa and play a part in selective zygosis in man.

The saliva seems to have similar characteristics.

Paul Popenoe.

Early Selection of the Teutonic Race

SELECTION did not work on the human stock in the same way in primitive times as at the present day in our advanced civilization. The primitive conditions were favorable to progress of the race, because the chances of survival were better in the stronger and more capable families. Under the conditions of advanced civilization this favorable selection is reversed, so that ability tends to be eliminated and the less capable elements of the race are preserved and increased.

The danger to the race through adverse selection is still overlooked, on account of the low state of biological information, even among educated people. Plants and animals are supposed to be selected, but not people.

The idea of human selection is no longer new, but has made rather slow progress toward general recognition. The contrast of primitive and advanced selection was clearly and eloquently stated in a book published in 1864, *The Roman and the Teuton*, by the Reverend Charles Kingsley, well known as the author of *Hypatia*, *Hereward*, *Westward Ho*, and other historical novels. Kingsley sensed the divergence between the interests of the race, as affected by selection, and the humanitarian policy of the Church, and saw the danger of continuing to increase the deficient and defective groups:

> The early history of the Teutonic race, therefore, is, and must always remain, simply the history of a few great figures. Of the many of the masses, nothing is said; because there was nothing to say. They all ate, drank, married, tilled, fought, and died, not altogether brutally, we will hope, but still in a dull monotony, unbroken by any struggle of principles or ideas. We know that large masses of human beings have so lived in every age, and are living so now—the Tartar hordes, for instance, or the thriving negroes of central Africa: comfortable folk, getting a tolerable living, son after father, for many generations, but certainly not developed enough, or afflicted enough, to have any history.
>
> I believe that the masses, during the early middle age, were very well off; quite as well off as they deserved; that is, earned for themselves. They lived in a rough way, certainly: but roughness is not discomfort, where the taste has not been educated. A Red Indian sleeps as well in a wigwam as we in a spring bed; and the Irish babies thrive as well among the peat ashes as on a Brussels carpet. Man is a very well constructed being, and can live and multiply anywhere, provided he can keep warm and get pure water and enough to eat. Indeed, our Teutonic fathers must have been comfortably off, or they could not have multiplied as they did. Even though their numbers may have been overstated, the fact is patent, that howsoever they were slaughtered down, by Romans or by each other, they rose again as out of the soil, more numerous than ever. Again and again you read of a tribe being all but exterminated by the Romans, and in a few years find it bursting over the Pfalzgrab or the Danube, more numerous and terrible than before. Never believe that a people deprest by cold, ill-feeding, and ill-training, could have conquered Europe in the face of centuries of destructive war. Those very wars, again, may have helped in the long run the increase of population, and for a reason simple enough, though often overlooked. War throws land out of cultivation; and when peace returns, the new settlers find the land

(*Continued on page* 467)

NAKED--A RECESSIVE MUTATION IN THE RABBIT

D. A. KISLOVSKY

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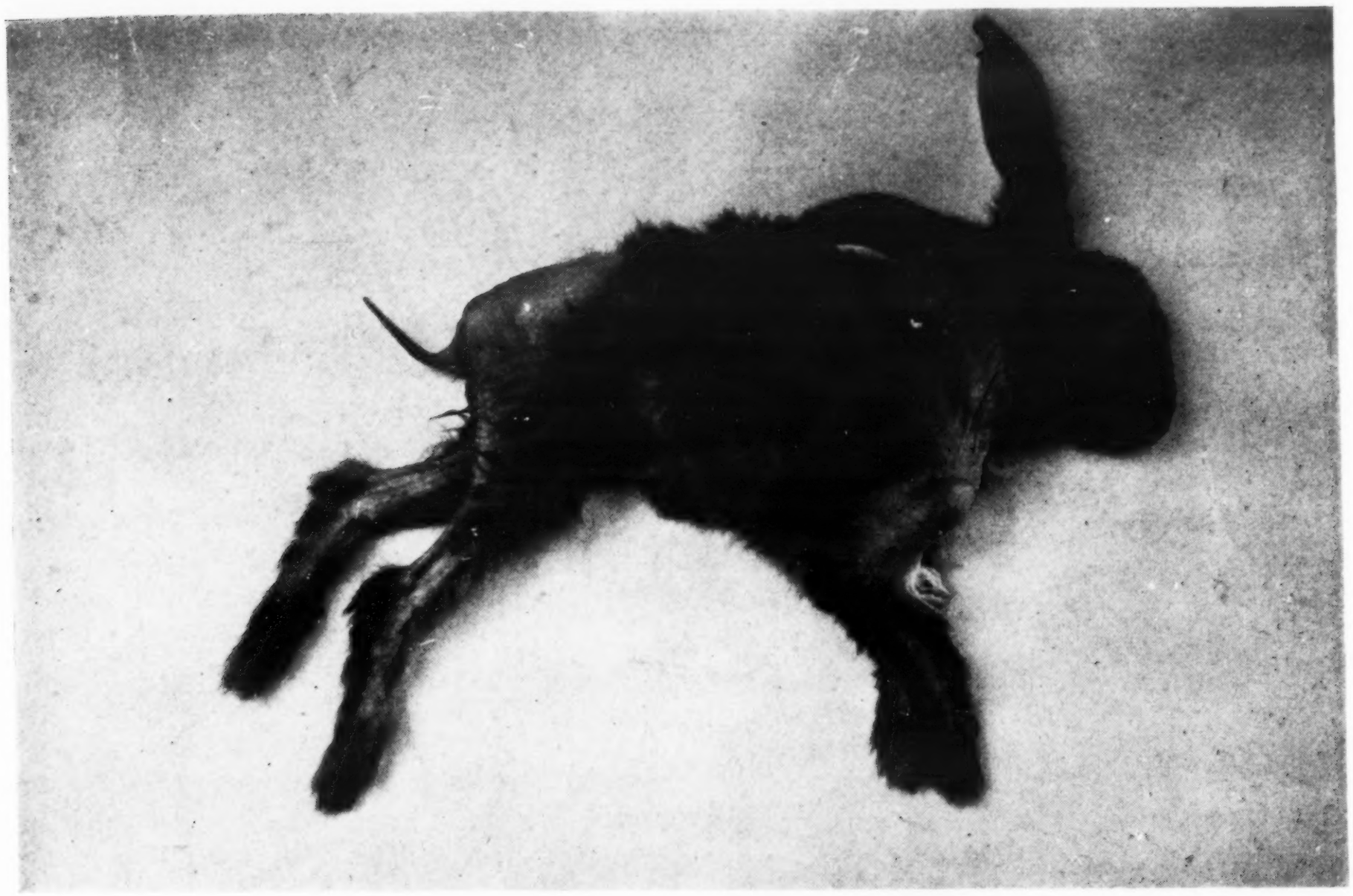
FORMS of defects in the hair covering have been described in several families of mammals: in the horse—(*Equus caballus*)[1, 2], in dogs (*Canis familliaris*)[1, 3], in cattle (*Bos taurus*)[1, 4], in mice (*Mus musculus, Epimus norvegicus and Peromyscus maculatus gambelli*), and in man (*Homo sapiens*). The hereditary transmission has been studied in dogs, cattle, and mice. In the dog it is said to be dominant, in cattle and mice, recessive. During genetic experiments with rabbits we met with a mutation that seems to be parallel to those mentioned above, and which may complete the list given by Gates. As is seen from Table I, the character appears to be a simple recessive. It appeared as the result of inbreeding, out of parents externally normal. We first met with it in a litter resulting from a daughter × father backcross (♀ 132 × ♂ 89) in June 1924, when a part of the litter (3 out of 6) was hairless. The remaining 3 were quite well covered with hair. The hairless young soon died, about the end of the third week. The fact attracted our attention and we mated the same sire (♂ 89), a silver champagne with his daughter ♀ 164 and two of his grand-daughters ♀ 248 and ♀ 249 daughters of his son ♂ 171. All of them were quite normal externally. In three of the four resulting litters (one from ♀ N-164 and 2 from ♀ 248) we had some hairless (or partly hairless) offspring. The same sire (♂ 89) had given with nine unrelated dams 49 quite normal offspring. His son ♂ 171 also gave, by five unrelated dams, 36 normal young. Dams 132 and 164 gave from different unrelated sires 17 young, all normal. This proves that all of them (♂ 89 and 171, ♀ 132, 164 and 248) were heterozygous. for the factor controlling the hair growth.

If we will take in account only one grand-daughter (the other, N-249 may be homozygous. She did not give any naked—out of five young). We will have the ratio: 12: 7 against the expectation, 14.25 ± 1.89: 4.25 ± 1.89. That is, the difference is only 1.18 times the mean error. (2.25 ± 1.89).

At birth all young were more or less alike. I first remarked the difference on the fifth day. At the time of leaving the nest (about two weeks) when their normal sibs were covered with smooth fur, the naked ones were nearly as naked as at birth. They had hair only on the muzzle (the forehead was naked), on the tips of the ears, at the back of the legs and a tuft behind the scapula (see Frontispiece). One had rather more hair covering, but nevertheless was quite defective: The forehead is naked, the neck is partly hairless, the skin covering the humerus is hairless, and the back, beyond the fourth rib, the pars sacro-illiacca and the third hind part of the femur; the back joint is covered only on the hind part with sparse fuzz; the tail is naked; on the belly and breast the hair-cover is very sparse. The remaining hair is rather long—about 1.5 cm.

In their general development (at about a month) the hairless rabbits were a little behind their litter mates. For instance, rabbit N-3 weighed only 147 gr. at the time his normal litter mate weighed 273 gr. at the age of 29 days. Out of these naked, three more were closely examined, two had defects in teeth. N-3 had his incisors quite deformed, needle-like and crossed over.



EXTREME HAIR DEVELOPMENT

Figure 1

An individual having rather more hair than two of his littermates (shown in the Frontispiece), but with seriously defective teeth, the incisors being needle like and crossed over. (This individual is N-3 of the text. N-1 and N-2 are shown in the Frontispiece.)

The gums of the lower jaw were wounded by them. N-2 (his litter mate, also son of ♀ 248) had his incisors rather too long and narrow, the right one being 1 m.m. longer than the left. The third one (N-1) seemed to have his teeth quite normal. This abnormality in the teeth, together with the hair defect, must be regarded as the cause of their premature death. None of them passed their first month. No matings could therefore be made between two hairless to prove definitely their recessiveness.

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TABLE I—Matings of Sire N-89

Dams	*Number of Progeny*	*Normals*	*Hairless*
2 normals unrelated	49	49	....
2 externally normal daughters	10	6	4
2 externally normal grand-daughters	14	11	3
Totals	24	17	7
Expected out of DR×DR matings	24	18±2.12	6±2.12.

QUENCHING THE LIFE OF THE FARM

How the Neglect of Eugenics Subverts Agriculture and Destroys Civilization

O. F. Cook

Bureau of Plant Industry

NO question is more important than the fate of agriculture in the United States, or more in need of careful investigation. Much is being written on the "farm crisis," but mostly without considering the biological factors that must largely determine the future of the nation and the race. The nature of the farm problems must be better understood if practical adjustments of the urban and rural relation are to be reached and maintained in the future. Much of the current literature views the farm situation complacently because so many improvements are being made in the technique and equipment of farming, as in a recent book called *These Changing Times*,* by E. R. Eastman. Even in a short period, since the beginning of the present century, many changes are observed in the conditions of farm life. Progress is recounted in many lines, transportation, communications, farm machinery, household equipment and sanitation; methods of production, farm organizations, cooperative marketing; schools, churches, and legislation. Such an inventory of current changes is pertinent, and evidently has been prepared with a desire to be hopeful and to avoid misgivings, but the note of confidence is missed. The times are always changing, but now are speeding too fast for the future to be projected. Valuable testimony is offered, though the case is not closed. "Yes, the American farmer has a future But to this statement there are several reservations."*

Grateful reflections are indulged on the many eminent and useful men from the farms who have had careers in the city. Keeping up good standards of life on the farms is considered necessary in order to maintain the quality of the people who are to supply the cities in the future, but the racial values of farm life are not reckoned. The stock-taking does not extend to the most important item, the farm people themselves, nor see in the continued drafting of the more capable elements from the farms to the cities a process of adverse selection which has the power to destroy our civilization, like others of the past.

The nature of the farm problems, the fields of study to be covered, and the urgency of finding solutions, are not adequately understood until the effects of urban selection are considered. Liberty enlightened the world from America because life was lived most constructively in American farm homes. The colonial and pioneer periods developed essential human values which are in danger of being lost through urbanism. Without the constructive life and discipline of the farm homes, our democratic institutions are at stake.

The selective draft from the country to the city is more effective than ever before. Many rural districts are declining, and the same state of rural depopulation that took place in New England may be expected for the country as a whole. The modern improvements of agriculture mean that every farm boy is a mechanic and a business man, more readily placeable in the city. The new facilities of communication,

*THESE CHANGING TIMES. A story of Farm Progress during the First Quarter of the Twentieth Century, *by* E. R. EASTMAN, editor *American Agriculturist* and author of *The Trouble Maker*. Foreward by L. H. Bailey. New York. The Macmillan Company, 1927.

automobiles, good roads, movies, telephones and radio, render the whole farm population accessible to the city as only the marginal districts were a generation ago. Greater inducements are offered every year in urban salaries and standards of living, compared with farm alternatives. The cities demand more people and consume them faster, men of forty years being discarded from industrial employment. More farm boys are needed because the supply of immigrants is restricted. Farming has become more precarious, and in some districts largely insolvent. Tenants and share-croppers are replacing the farm-owners and home-builders of the former generations. The last of the capable families leave a neighborhood because the others have gone.

The New England farm people are supposed to have moved to richer lands Out West, though probably a larger proportion disappeared in the towns and cities. Not only poor and unproductive land was abandoned, but even good land in easy range of city markets. The cities promised shorter hours and more dollars, and thousands of the farm homes were left empty. Most of the pioneering from New England was in New York and Ohio in the early days, before the industrial period. The regions farther west are settled largely from the South or by new immigrants. New England supplied many preachers and teachers to the South and West, but mostly to settle in the towns, rather than to populate the country. Relatively few people in the West are from New England or from Pennsylvania. More are from the rural South than from the industrial regions. Texas has drawn more of her people from Tennessee than from any other State, and now is furnishing a large proportion of new settlers in Arizona and California. As most of the natural increase from native-born Americans is in the country, the future of the race is represented by the farmers, not by the urban populations. The high quality of American farm people must be maintained as well as the high character of family life and training in American farm homes. Eastman sees clearly the function of the farm home:

> In the past, the farm and the farm home have been the great source of the nation's best life blood. Not only has it maintained a people on the land, strong, sane, wise and good, but the farm also has turned off a surplus of young men and young women who have built the cities and taken leading places in every profession and trade in the nation's life.
>
> Upon the foundations made and maintained by the farmer, America has built the greatest civilization of all time. With the plow and his sublime faith, which leads him forth to turn the soils with renewed hope each springtime, he makes possible all other industries of man. The plow and the man who holds it feed and clothe the world. The smoke of industry rises from a million plants. Railroads and the instruments of communication bind the world together. Ships sail the seas of the earth; great cities with inhabitants outnumbering the plowmen rear their massive buildings at every natural trade center. But without that which the plowman obtains from his scratching of the earth's soil, and without the men and women which the farm home gives to other industries, all would soon become as Nineveh and Tyre. . . .
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> Any study of the lives of successful business or professional men in America would show that a very large proportion of them were farm bred. The great question of vital interest to everyone interested in the future success of this nation is whether we are going to be able to maintain standards of life in the farm that will make it possible for the nation to continue to draw upon the farms for the high class human products that it has received in the past. (Eastman, pp. 172-5.)
>
> No wonder there is such deep seated love of the "little red schoolhouse" in all country neighborhoods. It is bred into our very blood. The local school for many generations has been close to the hearts of its patrons, and as the country has increased in population and developed in resources, other institutions have disappeared from country neighborhoods. Even the rural church is rapidly going. But farm people, especially in most eastern states, hang on with bulldog tenacity to the one-room school.
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> Yet out of these one-room schools of the past have come some of the greatest men and women the world has seen. These products of the rural school have gone back to the farms or into the towns and cities, and for generation after generation have outstripped their city cousins in almost every walk of life. Why? Because of the training they

received in the rural school? In some cases, yes. But in the great majority of cases, the men and women of our farms have forged ahead not because of the training or lack of it that they received in the schools but because they were the product of the greatest people and of the finest homes the world has seen. Woe unto us as a nation when the rural home begins to slip.

It was not so much the school that made the rural boys and girls later successful in life as it was those habits of stern responsibility which were trained into them early in life on the farm and in the farm home, the habits taught them by the thousand and one daily chores and tasks of the farm, that he who succeeds must ever put business before pleasure. No training on earth is quite so good as the habit which must be acquired early in life of doing the appointed task at the appointed time with no exception whatever. (Eastman, pp. 131-3.)

Interest in agriculture as representing the ideal and essential condition for the true progress and development of the human race was stronger in the pioneer period, and has been obscured in the recent decades of industrial, commercial and city-building activities. The principles of liberty and independence that inspired the beginning of our national life had their home in the country.

It was no accident that so many of the outstanding men in the early days of the Republic made notable contributions to agriculture. Their interests lay in farming; politics was merely their avocation. Even so accomplished a politician as Webster deplored the growing tendency toward industrialism. He could see only disaster to democratic principles in the urbanization of the population. "When tillage begins other arts follow. The farmers therefore are the founders of human civilization." Franklin is credited with introducing the first chemical fertilizers from France, Clay with importing the first Hereford cattle, and Webster the Duroc Jersey hogs. Jay devoted his leisure to the improvement of vegetables. Washington bred mules of notable quality and evolved crop rotation. Jefferson's contributions to agriculture were manifold, including many plant introductions and cultural improvements, and even the mathematical solution of the correct curve for the mold-board of the plow. These men were all farmers with scant respect for the tradesmen of the city. The glories of "Modern Business" had not dawned.

Effects of Urban Selection

It should be plain to writers of farm books that "the standards of life on the farm" are determined by the quality of the farm people. Agriculture is more than a means of supplying food and population for the cities. It has a greater function in developing and maintaining the race, though this is seldom considered. Civilization is a growth from agriculture. The conditions for generating civilization are those of rural life, with people living as families in separate farm homes. The children learn from their parents, and the more capable families have better prospects of increase and survival. The opposite tendencies are developed in cities, smaller families obtaining among the "successful" people, with the parental contacts restricted or abolished. Thus urbanism is a condition of adverse selection, where the race is depleted of its more capable families.

The activities of city-building have their beginnings in agriculture and are made possible by the continued support of agriculture, but eventually the stage is reached where the urban activities become parasitic and to the detriment of the race. Urbanism shows in many ways that the social structures of civilizations are susceptible to insidious disorders, like the malignant growths of cells that form tumors or cancers in animals and plants. "Even at the best the city is an ulcer on the face of the earth, a maelstrom, a minotaur, devouring the yearly tribute of the strength and beauty of the land."

Civilization is no more to be maintained without agriculture than a tree without its roots. The growth of civilization is not merely from the economic support of agriculture, but because the human material of urban civilization is

trained and supplied by agriculture. This is not a historical relation merely, to account for the origin of civilization, but is a continuing biological relation, as necessary to maintain civilization in the future as to develop civilization in the past. The decay of country life, not the decay of the cities, is the danger to civilization. Food to feed the cities is not the chief limiting factor. "The ability of a nation to maintain the integrity and vigor of its rural population is the real test of its vitality."

Improving the crops and the farm animals means little for the future if the human stock is to deteriorate through adverse selection. This danger has not been recognized in the past, but is plainly perceptible from the standpoint of our present knowledge of heredity. A new biological consciousness of the interests of the race is being aroused, but we may be waking up too late, like the Romans in the Age of Augustus. Many laws were enacted by the Roman Senate in a vain effort to maintain the family relations and avoid the consequences of urbanism. People who must be urged or rewarded to have children are already perverted. Most of the ancient families became extinct and Italy was depopulated, while the cities were replenished largely with Syrians and other Asiatics. Historians have deplored the loss of the Roman civilization as "the greatest backward step in the life of humanity of which history affords any clear record." The small Greek states developed "those mental gifts which have educated the civilized world . . . the rarest gifts of thought." Not only the lost arts of the ancient world are to be deplored, but the lost life, that urban conditions destroyed in a few generations, as the record of the Greek literature makes plain.

The Romans had been an agricultural people and became completely urbanized. "Many a nation has died by its own hand, but none by the hand of another." The powerful nations perish while the weak survive, as determined through selection. At the end of the Roman Empire a complete decay and destruction of the cities took place, so that conditions of natural selection were restored in Italy and other Mediterranean countries. The light of intelligence was dimmed for a thousand years, in the Dark Ages, but human ability blossomed again at the Renaissance, and entered another phase of urbanism and adverse selection. The pioneer centuries in England and America were a period of favorable selection for the Anglo-Saxon race, and now we are witnessing our American Renaissance, with its welter of urban prodigality and depletion, which Roosevelt interpreted as "race-suicide."

Until the effects of adverse selection were known, the decline of advanced races seemed very mysterious. The ancients believed that the gods were jealous and that human progress attracted special punishments. They even imagined a special goddess called Nemesis, whose particular function it was to see that all prosperity should be paid "by some turn of adversity." Philosophers have reflected much on the "decrees of fate," the "appointed vicissitude of things," and "the law of civilization and decay." Each of the races that has reached the higher stages of civilization has made the same mistake of urbanism.

The Roman system lasted longer than Augustus and the statesmen of his period had expected, because other human material was at hand in the conquered provinces to replace the original Romans and Italians. Let us not deceive ourselves because our system has expanded so brilliantly and drawn so many millions of industrial recruits from all parts of the world. The Roman system also controlled a vast area and brought many different races together under peaceful conditions of trade and communication, thus "welding them into an economic whole," as Ferrero explains:

> The unifying influence of these economic interests was so great, that the tendency which the empire then followed could never be checked, nor could the world be turned from the path upon which it had been started during the forty years of the *pax augusta* . . . . The plebeians of the country districts, the middle and upper classes, in a word, the whole of the empire, had been profoundly influenced by the continuance of peace and prosperity, by the return of the golden age, and by the merchants who introduced the principles of Greek-Oriental civilization together with their wares: all had been compelled to adopt the manners and ideas, the refinement, the corruption and the perversity of that city civilization which the Romans regarded as utterly pernicious. Towns sprang up in every district of the empire . . . the ancient cities of the Greek world grew in size and splendour: the grandeur of the empire was to be symbolized by the wonderful magnificence of its great cities and by the yet greater magnificence of Rome, upon which the emperors lavished adornment not only to please the inhabitants, but also to dazzle the eyes of subject nations and to command their respect. Agriculture was to share this universal prosperity, the peasant to live amid the comforts of plenty; but the spirit of country life, the simplicity, the thrift and the old-fashioned austerity which Virgil had sung in his Georgics, was doomed to vanish. The vitality of the country was sapped by the towns, which absorbed wealth, intellect and energy for conversion to vice and luxury: those districts became most prosperous which could supply the towns with oil and wine for their feasts and games. Landowners great and small settled in the towns, and spent their wealth in building baths, giving popular shows and distributions of corn and oil: town-life exerted a growing power of attraction upon the peasant in every district and from generation to generation.*

Building great cities has been the traditional way of displaying wealth and power by the more capable races of the past, but building a greater race would be a higher ambition. The question of adapting our social and economic systems to the progress of the race is overlooked in the blind struggles of class interests which are only repeating the histories of other urbanized civilizations. A normal development of civilization would lead toward a full attainment of human ability. It is an obligation for the race, as for the individual, to be as intelligent as we can. Happiness, as the young Napoleon declared, is the highest development of our talents. Urbanized races deteriorate because the more capable families become parasitic, stop developing their full ability, and stop reproducing. Agriculture is the accumulating, advancing phase of civilization; urbanism the dissipating, declining phase. Continued development is required for continued existence.

Turning the world from its urban path may not be more feasible now than in the early Christian centuries when the Roman civilization declined and fell. How urbanism is to be resisted and a higher agricultural civilization developed, is a problem still unsolved, as flying was before Langley and the Wright brothers. From Daedalus to Darius Green, many had tried, but the problem of flight had to be more thoroughly investigated before solutions could be found. The farm problem also is very old, but not on that account to be declared impossible of solution.

The first requirement is to see that there is a farm problem, and that it needs greatly to be studied, so that we may reach a clear understanding of the rural and urban relations in the structure of civilization. It is not sufficient that we take sides in the ancient and inevitable struggle between rural and urban interests, or that we feel sharp reactions against particular forms or facilities of urban decay, as lotteries, gambling, alcohol and narcotics. Prohibitions and palliatives are not sufficient. We shall not be on safe ground until the tendencies of the system are changed. The only corrective of too much urbanism is to develop better living in the country. The "modern improvements" of the household, the sanitation and health protection, the right kinds of schools, churches and social contacts, and all of the really good and desirable things that now are

*Ferrero, Guglielmo (translated by H. J. Chaytor), *The Greatness and Decline of Rome*, 5:346.

sought in the city must be provided in the country, so as to leave no occasion for the sense of privation, inequality and injustice that afflicts and embitters many farm people. Much that the cities have is needless and wasteful or positively injurious, but also the cities have much that is needed in the country. No simple solution of the farm problem is to be expected, but a future of progress may be opened through a better understanding and appreciation. Positive developments of farm life are called for, and on many lines. Our ideals and intentions regarding farm life must be changed if new paths of development are to be sought and entered.

Science is the new feature that makes our modern world different from the ancient. The best hope for agriculture is that the farm problems are being investigated with greater care and diligence than at any former period in the world's history. The demand of the farmers for more of the knowledge that is needed to solve their problems is embodied in a nation-wide system of experiment stations and local advisers, with offices, laboratories, and libraries, which have constructive contacts with millions of individuals and with thousands of cooperative associations. It is expected from these efforts that "the next generation will be endowed with a strong nucleus of men and women trained to initiative and responsibility and equipped with a zest for improvement." Yet the need for ability must not be overlooked, no less in the practical field for making use of scientific discoveries, than in the technical field for making the discoveries. Eloquence and inspiration no longer are trusted to give us practical solutions of complicated problems. Confidence is to be enlisted only by careful study and testing of the facts, so that their relations can be clearly understood and adjusted. The methods of modern science have definitely superseded the ancient confusion of ideas that took persuasion of the people for solution of public problems, and placed the eloquent statesmen in the class of "divine men," with the inspired oracles and prophets.*

The orators win the arguments and the generals win the wars, but these are not solutions of the problems. The race questions and the farm questions are good examples, showing how issues may be carried to desperate extremities without any clear understanding on either side. Talking or writing, praying or fighting, are alike hopeless if we refuse to open our eyes and look carefully at the facts.

The Teaching of Selection

A wonderful new era of agricultural civilization in the United States may be projected, if full use can be made of the modern facilities that render farm life at present so different from what it was even a few decades ago, but the quality of the rural population will determine the extent to which the new equipment can be applied to a higher development of the life of the race. If ability declines, the outlook is to a more rapid decay of agriculture, rather than to a new adjustment of farm life on a higher plane. The teaching of selection is that we must choose the kind of race and nation that we wish to be, and arrange to grow in that direction. "It is time for man to plant the germ of his highest hope," and to

*"*Socrates.* Now do not those men, O Meno, deserve the character of divine men, who either speak or act aright in many things of great importance, without any intellectual knowledge of the subjects concerning which they speak or act?

"*Meno.* By all means do they.

"*Socrates.* Rightly then should we call those men divine, whom we just now mentioned, the oracle singers and the prophets, and all who are inspired by the Muses. Nor at all less divine men than these should we say that the politicians are, no less enthusiasts, inspired divinely, and possessed by the Divinity, when in their speeches they direct aright many and great affairs, without any real knowledge of the subjects they are speaking of." (Plato, The Meno. Translated by Floyer Sydenham.)

provide the conditions of growth and continued reproduction. Only the future can determine how far our race may develop, if scientific interest and constructive ability are applied to the solution of our farm problems. The saving response and reaction from urbanism must come from those who are still on the farms, and must not wait till adverse selection by the cities has been carried too far. The finest people may be in the cities, but they will not come out, they nor their children. Their eyes are not open to the future of the race or to the world of nature. The effects of selection on the quality of the race are more readily understood by farmers than by city people, and should not be ignored any longer by students of farm problems.

A false idea of selection is abroad, for which Darwin appears responsible, in making selection appear as the cause of evolution. Not only the general public is somewhat misled, but also many special students and writers on evolution have failed to get clear on this point. Selection does not cause evolution, though having an important relation to the evolutionary process. Natural selection is the effect that the environment has on each species of plant or animal that exists in nature, of cutting off some of the lines of descent, while other lines go on reproducing and evolving, to form the species of the future. Selection works entirely by elimination. It is not in the nature of selection to cause any new characters to appear, or to cause any changes of characters to take place. Selection has no power to create anything, but has a very definite power to destroy. If the tendency of our civilization is to eliminate the more capable families and lines of descent through urban selection, we may be sure that our race will decline in ability. Sending the bright boys to the city is a losing game for our civilization to play. It is the same kind of folly as planting poor seed or selling the best breeding stock to the butchers. The eliminating function of the city would be useful if properly applied, but now is working adversely. Capable people must live in the country if there is to be progress in agriculture, and the standards of farm life are to be carried higher, instead of being allowed to go down. The cities and the suburbs are being improved and beautified with palaces and gardens to the limit of luxury and taste, but these do not balance the withdrawal from the wholesome realities of farm life. That a decline of rural intelligence is perceptible, even in a single generation, this good friend and advocate of agriculture is forced to admit:

> There were many persons of the older generation who liked the Abraham Lincoln type of reading, a kind of reading that was done so well that the thought of the author was impressed forever upon the mind of the reader.
>
> In the farm community where I was raised, I can think, for example, of several men of the older generation who could quote from memory and discuss intelligently Shakespeare and many other classical writers. Today it would be difficult to find many such men in a whole county.
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> It is a well known fact among book publishers that farmers are poor customers. On the other hand, there is no doubt that the *average* education which comes from reading is higher in country districts than it was a generation ago because many of those of the type who read little or nothing today of the classics do pick up considerable information from current magazines and newspapers.
>
> It is hopeful sign, not only for agriculture but for the country as a whole, that there seems to be an increasing tendency in the modern dailies to pay more attention to farm matters. Many of the daily newspapers, particularly those with a large rural circulation, conduct a farm page. I question the value of most of this work, however, for it is likely to be done by writers who are not close enough to the practical affairs of the farm. But I do not question the great value of the dailies in furnishing up-to-the-minute market reports and accurate and full detailed reports of all news that bears upon the farm business. (Eastman, pp. 24-26.)

Study of Farm Problems

Even the market news is of questionable value when it leads farmers to gamble on their crops, instead of establishing balanced systems of produc-

tion. It would be a great service to agriculture if economists would convince farmers of the futility of chasing the markets, instead of encouraging such instability. Over-production is largely speculative production, which defeats its own purpose. Regular quantities and qualities of farm products, maintained for periods of years, would encourage consumption and allow industrial uses of cotton or other raw materials to develop without the frequent setbacks occasioned by spasmodic production and speculative price fluctuations. That these factors are not considered only shows how little progress has been made in the study of the farm problems.

Millions of dollars are wasted in the cotton industry by casual changes of varieties and general mixing of seed at the public gins. These sacrifices continue although it is generally admitted that production could be much more efficient if only one kind of cotton were grown in each community, and the seed kept pure. This would standardize the quality of the fiber, with only the difference of field conditions and handling to be taken into account, and would give a solid foundation for a stabilized industrial system. A product like cotton, that can be stored from year to year without appreciable deterioration, and at relatively slight cost, could be supplied at regular rates, like water from reservoirs, and the hazards of speculative trading avoided. Everybody uses water, but so does everybody use cotton. Engineering skill has been supplied to building and operating water systems, but not to handling the supply of cotton.

New features have been added to our social and legal institutions in the irrigated valleys of the West, to the end that the farmers are assured of regular supplies of water. As members of water-users' associations, the farmers themselves are responsible for building and operating the irrigation system. The development of the water-right institutions suggests a further possibility, that rights of production and access to markets may also be recognized for associations of responsible producers. Farming has changed from the family basis to the commercial basis, which calls for more definite relations of the producers to each other and to the channels of trade, as irrigated farming necessitated a cooperative relation to the supplies of water. Orderly market relations are as desirable as orderly water relations. Stabilized production and prices of cotton and other essentials would be of advantage to farmers and manufacturers, and to the consuming public.

Present conditions in the cotton industry are commonly considered backward, but perhaps should be viewed as forward conditions, in line with tendencies to vicarious farming from the city. The urban leaders try to foster agriculture by lending more money to the farmers, which is all that the city can do for people in distress, but urban inflation of agriculture is ruinous to the regular producers. Tenants and share-croppers are subsidized, to the detriment of farmers who are striving to maintain good standards of living. The cotton industry is notably handicapped by great numbers of irresponsible producers, kept in the field by borrowed money. With any prospect of good prices the crop is at once over-planted, without regard to the interests of the normal farming community. Costs of production are enhanced, quality and reputation impaired, and markets disorganized, so that more of the farmers are reduced to the state of dependents. The relation of loaning facilities to living facilities and improvements of production needs especially to be studied. A gradual restriction of the crop loan system might prove to be a very constructive measure. No crop is better adapted for being stored and held over by the farmers when prices are too low, but cotton that belongs to the factor or the banker must be sold or turned in as it

comes from the gin, and in most of the primary markets there is no discrimination in price to encourage the production of good fiber. A progressive farmer who raises better cotton than his neighbors has little prospect of selling it at a better price, so that the motive of improvement is lacking, under the present system.

Experience in the cotton industry has shown that irresponsible producers not only depress prices but keep production on a low plane by preventing the utilization of superior varieties with better and more uniform staple. Destructive reactions appear as soon as a superior variety attracts favorable attention, so that profits are expected. The more promising the variety, the sooner the cycle is run. It requires only a few seasons of careless inflation of production to destroy the commercial reputation of even the best variety, either by extensive planting of mixed seed or by raising the crop under adverse conditions, where the fiber does not reach its normal development. Buyers are soon disappointed and ready to believe that the variety has "run out," even before it has been placed fairly in the market. The belief in running out has the strength of a veritable superstition with no popular understanding of the cause, from mixing and crossing of varieties.

It is only in communities of more intelligent and responsible farmers that superior varieties of cotton can be utilized, where improvements of production can be applied and satisfactory market relations established with the buyers or manufacturers. Communities of renters and share-croppers are in no position to deal constructively with marketing or other community problems. Local intelligence, interest and leadership are prime factors of community progress through study and application of scientific improvements of production. Producers' organizations possibly could be developed in the future to the extent that a constructive control of production might be exercised by the farmers themselves, as by urban industrial groups.

As the farm people of the United States have more contact with towns and cities and as through better education and means of communication they come into a larger participation in all the ranges of human culture, they come to realize that only through collective effort can they secure many of their new desires. . . . The family becomes less self-sufficient, but through its wider associations in the community, the relations of the members of the family to each other assume new and—because they are more largely voluntary—higher values, and the family attains its highest development through the larger fulfilment of its members.

The farmer no longer glories in his isolation, or magnifies the virtues of independence, for new conditions require the cooperation of the whole community if farm life is to be made satisfying. Willingness and ability to work with others for the common good win social approval. Next to devotion to the family, loyalty to the community is essential for the realization of the best possibilities of rural life.*

Eugenic Standards Needed

It is admitted that farming should be placed on an equal footing with urban industries and commerce, but the ways of making such an adjustment have not been found, and may require new explorations and discoveries in the field of human biology and social institutions. Undoubtedly, the farm problems are difficult, since they were not solved by any of the nations of the past, or their systems of civilization would have been maintained. The highest grades of intelligence and character are needed, not only to formulate the general principles of agricultural civilization, but to work out the practical adjustments.

Farmers are told that they must solve their own problems, but how is this to be expected if the more capable members of each generation are drafted to the city? The country loses by default, with all of the able counsel engaged on the other side. As Eastman says, "Without a doubt the largest limiting factor to progress in cooperative mar-

*Sanderson, Dwight, *The Farmer and His Community*. 1922, pp. 244-245.

keting is the lack of enough good leaders." Urban parasitism luxuriates because practical solutions of farm problems have not been devised by men with the right interest and ability. Too many farm leaders have urban viewpoints and divided interest. How the competent leadership is to be supplied, is as much a part of the farm problem as any other factors that are being investigated. Not only the leaders must be intelligent, but the community also, if practical cooperative systems are to be established and maintained. Communities of capable farmers may develop as functioning social organisms.

From the standpoint of eugenics a new approach can be opened for more practical study of the farm problems. The single life is too short a base-line to give us good angles of judgment on general questions of human welfare and civilization. The farm values stand out and take practical bearings when the race interest is appreciated. Agriculture is not merely a problem of production, but a problem of living and continuing to live, from generation to generation. Practical eugenics and the improvement of farm life have the same objective of higher human attainment. Heredity and selection are biological facts that are being applied to agriculture and are of equal pertinence to human interests.

It is a mistake of some writers to suppose that the methods or breeding devised for plants and animals are to be applied also to people. Reducing the human race to the uniformity of an "improved" variety certainly is not the purpose of eugenics, but to extend the diversified abilities of mankind. The economic and social adjustments that determine the formation of cities are among the "agencies under social control" postulated by Galton as the basis of eugenics, "that may improve or impair the racial qualities of future generations, either physically or mentally." Urban selection has the sinister power of impairing the quality of future generations. Eugenics shows the way from this disaster, by leaving the more capable families on the land and withdrawing the less capable.

More farm gospel is being preached about pigs and chickens than about children. As one writer has said, interest in heredity may begin in the barnyard, but should not end there. The practical knowledge of selection no doubt had to come by way of the plants and animals, but there is no question that it applies to our own life as well. Every sound and competent farm boy should know with clearness and conviction that he must watch, and wait if necessary, for a sound and competent farm girl, and be very careful to find the right one! Not only family loyalty and pride of good judgment may be enlisted behind such ideals, but every sentiment of responsibility and consideration for the children, who have a right to be born and raised by healthy, intelligent parents.

Eugenics means deeper regard and satisfaction of our human nature. Our lives are more than meat, our bodies more than raiment. The applications of heredity to plants and animals are valued highly, while the human applications are not considered. How could we show more plainly that we are blind to our most vital interest? Our parental instincts are the strongest and most permanent, but are not yet enlightened, or the urban bait would not catch us. The farm questions go back to the human questions, of sharing the normal life and instincts of our race, and seeing a future before us that our race may continue. Eugenics is the scientific projection of our sense of self-preservation and our parental instincts. We would not prejudice the future of our children by taking wrong courses in our generation. We dare not entrust the future of the race to an urbanized posterity. Our great industrial cities are amazing, but not human or enduring. The splendid offices, apartments, and hotels are for childless people. It is a strange madness that drives us to build these im-

mense piles of masonry and steel, and herds us into them, as though we were bent upon the fate of the Athenian army that perished in the quarries of ancient Syracuse.

Education for the City

Farm life lacks consciousness, so that it can not express adequately its own satisfactions, nor value its own possibilities for an ideal development of the race. "Farmers richly blest could they but know . . ." as the Roman poet said, but urban felicitations on the joys of farming no longer satisfy. The future will not be assured until the farmers have the blessings and also the knowledge and taste to appreciate. This is another requirement of the highest ability on the farm. Ancient wisdom and modern knowledge must be fused into more ideal life. The plow-boy may have much that Plato lacked, and must know what it is, and how to project his higher appreciation of life through many improving and advancing generations of able-bodied and able-minded farm people. His ability must not place him in any forced draft to the city where he or his children are to be restricted and sterilized, and the family extinguished.

Our city-draft operations at present are well organized and very efficient. Each likely lad with a good headpiece is thoroughly coached to believe that he should get an education that will enable him to do "something better than farming." The advantages of wealth and importance, the responsibilities of leadership and the claims of sympathy or duty are driven home by all the good people. Parents and teachers, preachers and editors, are serving as procurers for the city. The traffic of youthful ability to the city is so much a matter of course as hardly to be considered as a factor of the farm problem, or reckoned in the study of migration to the city. Some writers are reassured because they do not find many of the more competent and successful adult farmers selling out and moving to the city. The sons and daughters of such farmers, who are being educated and settled in the city, are not counted as withdrawals, but the effect of urbanizing the family is the same. The fault goes back to the school where we should be educated for country life, but are trained to live in the city.

One writer on farm problems has definitely challenged the export of ability from the farms as a misguided activity of the rural churches and schools:

> Unfortunately churches in the country are too often recruiting stations for the cities and colleges. The ministers are respectable pullers-in for the city show. Nothing rejoices them so much as to help their young men and women find a position in the city; unless it be to have a bright lad or girl go off to college. When a country minister was reminded that all these departures weakened the country community, and that very few of them benefitted the lad or girl who goes to the city, he replied, "you cannot blame them; there is nothing here to keep them."
>
> "The rural exodus" has had its Moses in the rural college student, its Aaron in the country minister, and its Miriam in the country school teacher. These three have led a generation out of the country to perish in the wilderness. For only a pitiful few of those who leave the country come to prominence in the city. The most gain but a poor living there, and very many go to ruin. The church should be the savior of the community, as her Master is of the soul.*

Neither is prominence the chief end of man, nor the prize to set before youth. The teachers and preachers must get the farm gospel before others can be blamed. Not selfish ambition, but the desire for knowledge is the virtue that true education would foster, as the basis of right action and social responsibility. The development of genuine facilities of education in rural communities is one of the steps to take in meeting the farm problem. The best schools must be in the country, to hold the most intelligent people—not the largest school buildings nor the longest periods of instruction, but the most effective contacts with the world of knowledge. An art of learning is

*Wilson, Warren H. *The Evolution of the Country Community*, pp. 87-88.

needed more than an art of instruction. Pedagogy is on the wrong track. The false emphasis on formal instruction is tending to discourage education.

Large schools are no advantage. With too many pupils together, crowd psychology is developed, rather than independent mental resources. The country is the best place for schools, as the ancient Greeks recognized. Also in the pioneer period of our history many schools were established in the country, that now are surrounded by towns and cities. It is only a misplaced industrial notion that big buildings make better brains, or make them faster. The true purpose of education is defeated when the school is turned into a treadmill that has to run for so many hours in the day and so many weeks in the year, to keep the city children off the streets. The city schools are not a solution of the farm problem, but are one of the urban liabilities that rural intelligence must avoid.

Agricultural education in schools has been an insistent demand for several decades, but is hardly a reality as yet. Courses in agriculture have been added to the scholastic system but the objects of farm education are not attained. The habits of the school are not a preparation for the life of the farm, so much as a training for urban activities. Also the professional educators apparently took it for granted that boys who were going to be farmers would not need to know much but farming. So the scheme was set for second-class minds, and few men of special ability have been attracted to the study of the farm problems. There has been little recognition of the farm problems, and it has not been the fashion to study such problems in our schools. More high-class scientific talent has been applied to the study of the remote stars than to questions of human welfare. An actively intelligent farm youth is anxious to know as much as possible about the world at large, and usually does not go to an agricultural college. A broader and deeper education is needed for living adequately on the farm than for doing business in the city or adorning the scholastic professions. The past and the future of the world mean something to the farmer, but have little meaning in the city.

What the farm schools of the future are to be, is not yet apparent. Education is a normal instinct no less than parentage, and a function to be exercised by the whole community instead of being relegated to a few overworked and under-paid substitutes. Eastman was entirely right in seeing that the real training of farm life was in the home instead of in the school. It must be a contolling principle in the development of rural education that the schools shall broaden and enrich the home life, instead of restricting the parental contacts. Perhaps the short-term district schools can be developed in the direction of the rural "folk-schools" of Denmark, a possibility that is now being studied and tested in North Carolina.

The present scholastic system is extremely artificial and unpractical from the standpoint of eugenics. For purposes of "higher education" the more intelligent young people are kept in school during the years when the family instincts are the strongest, while no such handicap is placed on the less capable members of the community. Nobody has suggested that people between 20 and 30 should be excluded from schools, unless they are married. The idea that facilities of education are only for children and unmarried adults is a survival of monastic traditions. It should be considered more important to educate parents than celibates. Going to schools like ours does not appeal to mature, responsible people, but real educational opportunities in the country would appeal to all ages.

An eminent educator has said: "Habits of scientific investigation are exceptional, and must always be confined to a few." On the contrary, it

should be recognized that scientific interest is a normal attribute of capable minds, and needs only to be appreciated and developed in order to become general. Scientific farmers are required for scientific agriculture and advancement of farm life. The world of nature is close at hand for the farmer, and the worlds of science, literature and art are within his reach. Why should we live among the wonders of creation and not see them, or remain oblivious to what human ability has accomplished?

To be concluded in the November number. Extra copies of reprints of the complete paper may be obtained from the editorial office of the Association. Price, twenty cents each.—*Editor.*

Color Mutations in the Tulip

MR. BENJAMIN C. AUTEN of Carterville, Mo., has recently sent an interesting series of photographs of color mutations in tulips, one of which is reproduced on the cover of this number. The flower shown there is from a plant of the Ellen Willmott variety. The color of the flower is the normal pale cream, except for a splash of red on one of the petals.

It is suggested that this represents a flare-up of an ancestral red, possibly recessive, which has been brought to light by somatic segregation of color factors. The blotch appears on both surfaces of the petal, but it does not go clear through at any one point, i. e., where the outside of the petal is red the inside is normal cream, and *vice versa.*

For a number of years Mr. Auten has marked bulbs showing such color mutations, but he has not observed any inherent tendency toward such variations.

For the Poultryman

PRACTICAL POULTRY FARMING, by L. M. HURD. Macmillan Co., N. Y. 1928. Pp. xxiii—405. Figs. 149. $3.50.

This new book is a simple, straightforward and conventional description of practical poultry-keeping methods for beginning poultrymen and general farmers. It covers the wide range of subjects now involved in any poultry enterprise: housing, hatching, brooding, feeding, culling, breeding, treatment of diseases, marketing, etc. The best parts of the book are those dealing with practical methods and appliances for general management of fowls, which are modern and useful. In general, little attempt is made to provide scientific justification for the practices recommended or even to mention the biological principles underlying the poultry industry. Heredity and breeding get a scant seven pages of outmoded and useless definitions.

L. C. D.

THE MORPHOLOGY OF INTERMEDIATE RUMPLESSNESS IN THE FOWL

With Remarks Concerning Hereditary and Accidental Rumplessness

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IN the course of our breeding experiments with rumpless fowls, a new character was found in 1925 for the first time representing an intermediate condition between complete rumplessness and normal tail.[8] This character, which we shall call "intermediate rumplessness", apparently is a genetic modification of the rumpless condition, since all intermediate rumpless birds tested have been shown to carry the rumpless gene. A report concerning the mode of inheritance of this trait will be published later.*

For a morphological study of intermediate rumplessness, we have examined 23 skeletons of adult birds and the pelves of 11 chicks immediately after hatching. We have re-examined our material of hereditary and accidental rumplessness with regard to certain problems, and we have compared the pelves of newly hatched intermediate rumpless chicks with those of normal and rumpless chicks.

Externally the intermediate rumpless birds frequently differ from chickens with complete rumplessness by the presence of a variable number of tail feathers. In rumpless fowls the complete absence of tail feathers is the rule, although, occasionally, up to three tail feathers have been observed. In the intermediate rumpless fowl, however, some tail feathers usually are present. The highest number of tail feathers in the birds of which the pelvis was examined was eight as compared with approximately fourteen in the normal chicken. But the examination of birds which are still alive seems to indicate that in rare cases all tail feathers may be present. The following list gives the number of tail feathers of some of the birds which we have observed, arranged in order of the length and differentiation of the skeleton of the tail.

Sex and pedigree number	*Number of tail feathers*
♂ 1482	4
♂ 1475	8
♂ 1464	7
♂ 1481	8
♂ 1470	8
♂ 5409	2 or 3
♂ !471	5 or 6
♀ 1368	7
♀ 4887	1
♀ 1358	0
♂ 1210	8
♀ 1707	3

It appears from this distribution that neither sex nor the degree of differentiation of the caudal part of the vertebral column exert an important influence upon the number of tail feathers.

In most cases no oil gland (uropygial gland) was found externally in intermediate rumpless birds. In two instances, however, glandular tissue could

*Davenport recorded the following observation: "In the case of a rumpless game remale dissected by me, there are two unsymmetrically formed and intimately fused vertebrae behind the fifteenth synsacral—the posterior limit of the sacral vertebrae. That there are two is shown by distinct transverse processes with spaces for the passage of the nerves. Behind these is a knob of bone about 1 mm. in diameter. These three elements constitute the entire caudal skeleton. It is profoundly reduced from the normal." Possibly this bird was intermediate rumpless, although in the absence of a detailed morphological description and of breeding data, this cannot be established with certainty.

be seen below the skin in the region of the oil gland, representing probably a part of the uropygial apparatus. In a few cases a small external oil gland was present and appeared to be functional in at least one of them. It seems that whenever an external oil gland is present the number of tail feathers approaches the normal condition.

The skeletons of the intermediate rumpless birds form a graded series from an almost normal (Figure 2) to an almost rumpless condition (Figure 5). In all cases, however, the pelves of intermediate rumpless birds are easily distinguished from the normal or rumpless types. All the pelvic bones seem to be entirely normal; the same is true for the vertebral column anterior to the synsacro-caudal region, with the exception of variations occuring in both normal and intermediate rumpless fowls (as for instance the absence of sacral ribs on one of the synsacral vertebrae).

In the synsacro-caudal region of the intermediate rumpless pelves either one or two vertebrae are absent. Only in one case we observed the presence of all five vertebrae. In this respect the intermediate rumpless birds closely resemble the complete rumpless condition. Before giving a detailed comparison of this region, we shall describe the caudal segment of the vertebral column in intermediate rumpless fowls.

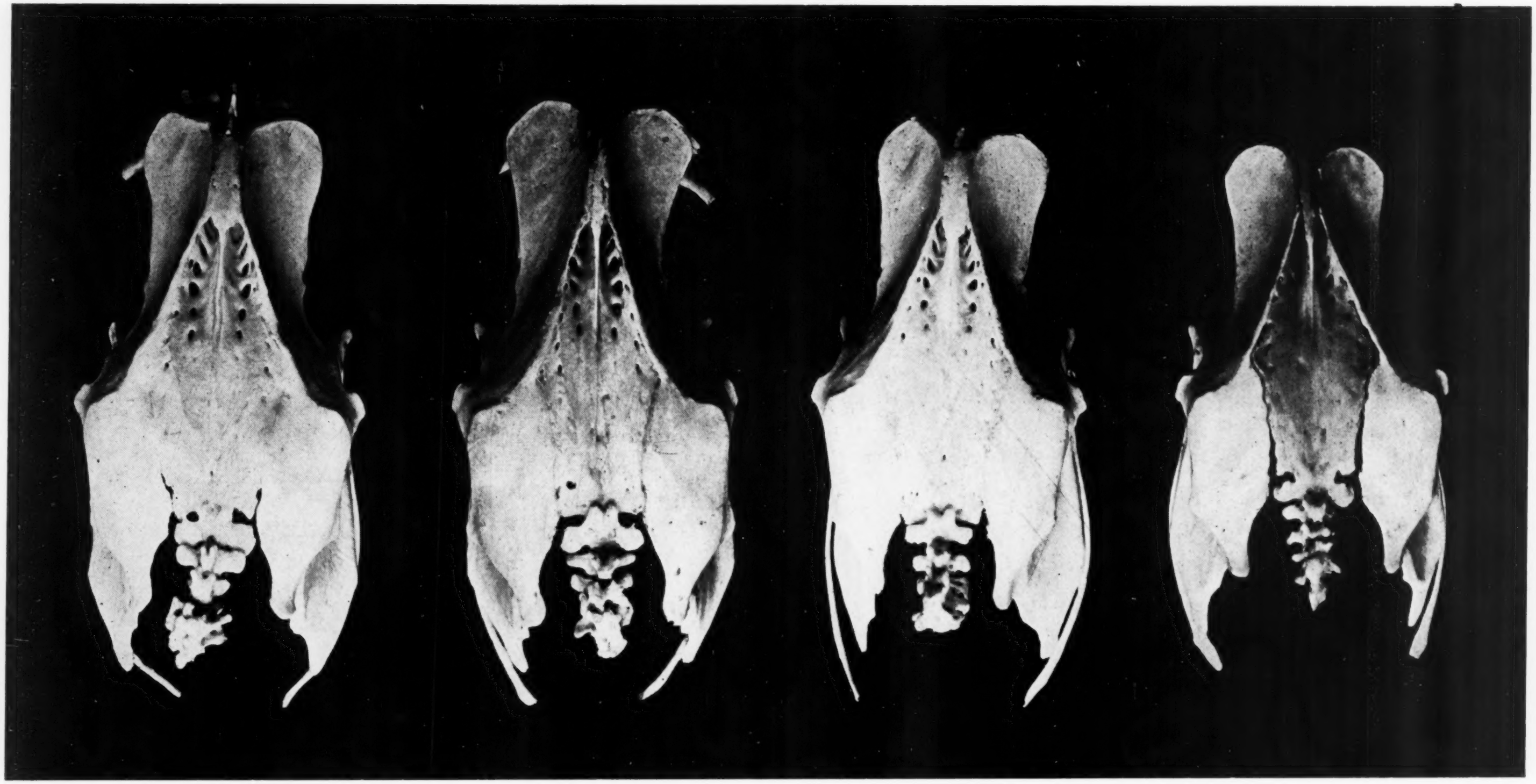
The most important feature of the intermediate rumpless condition as compared with complete rumplessness is the presence of caudal vertebrae. The table at the end of the paper gives a short description of every one of the skeletons which we have observed. It can be seen from this table that in all except the two most reduced cases all five caudal vertebrae are present. In the most differentiated case (♂ 1482), the first two tail vertebrae are free and approach normal appearance. In five other cases the first caudal vertebra is free. All remaining caudal vertebrae in these cases, and in the other instances all five caudal vertebrae, are fused with each other in a more or less irregular fashion. As a rule, size and degree of differentiation of the caudal vertebrae decrease in an anterio-posterior direction. Usually a higher degree of fusion is to be found on the dorsal than on the ventral side. In the majority of cases we find that all the caudal vertebrae dorsally are fused into a plate-like structure on which only traces of the processi spinosi dorsales can be seen. The processi laterales of all the vertebrae frequently are present, although very short and many of them in an irregular position. The less the caudal vertebrae are developed the more reduced are the lateral processes and the more frequently occur fusions between two or more of them. It is striking also that in the more reduced cases the knob-like lateral processes more frequently are found in a very irregular position, be it towards the dorsal or more frequently towards or on the ventral surface of the fused vertebral bone. In the two most reduced cases of the series only four (♀ 1356) and three (♀ 4647) caudal vertebrae, respectively, can be traced with certainty, although the presence of remnants of lateral processes of five vertebrae appears very probable in the former. The skeletons of day old chicks show fusions of the caudal vertebrae similar to those which we have found in the adult animals.

The classification of the skeleton according to the size and degree of differentiation of the caudal region of the vertebral column shows that sex plays an important rôle in the process of differentiation. In the first half of the series nine out of twelve birds are males, whereas the second half consists of two males and nine females. The first five animals in the series all are males, the last five all are females. Although the anlagen for all caudal vertebrae appear to be present in all cases, it is evident that the male sex furnishes an additional stimulus for

growth and differentiation of these vertebrae. It has already been noted by Van Oort that in the group of Phasianinae (to which the domestic fowl belongs) the pygostyl is larger in the male than in the female. This probably is another expression of the influence of sex upon the differentiation of the caudal part of the vertebral column.

In all cases we have found a small, bony protuberance at the caudal end of the vertebral column, fused with the caudal vertebrae. This protuberance, according to our observations on newly hatched chicks, represents the last two of the vertebrae forming the pygostyl. Its shape and location is very irregular. In the day-old chicks the shape of this bone is identical with the fused last two vertebrae of the pygostyl. Its size, however, is somewhat greater than that of the same bone in the normal chick. There is no vestige of any kind of the remaining vertebrae of the pygostyl. According to du Toit the pygostyl consists of six vertebrae of which the last two fuse on the eighth day of incubation. From there the process of fusion progresses anteriorly, and supposedly is completed by the 17th day of incubation. Our observations, made on normal day-old chicks, are at variance with this report. In twelve out of twenty-one cases the pygostyl consisted of six vertebrae, whereas in the remaining nine cases seven vertebrae have been found. Only in one case all vertebrae were fused, in one other case the last five vertebrae were fused and the first two free, and in a third case the fifth vertebra was incompletely fused with the last two. In all the remaining cases only the last two vertebrae of the pygostyl were fused at hatching time, all others (4 or 5) still being free. This situation suggests that the anlagen for the first four or five vertebrae of the pygostyl in the intermediate rumpless birds are missing from the beginning, and that the remains of the pygostyl forming a protuberance at the end of the vertebral column are homologous to the last two vertebrae of the normal pygostyl. Further proof for the correctness of this assumption was provided by an examination of the pelves of twenty newly hatched rumpless chicks. Because of the close resemblance between the end of the pygostyl present in intermediate rumplessness and the protuberances at the caudal end of the pelves of hereditary rumpless birds, it was of some interest to decide whether these protuberances in birds with complete rumplessness have a developmental relationship to the pygostyl. The preparations from newly hatched rumpless chicks have shown that these protuberances represent, indeed, the last two vertebrae of the pygostyl. As in the intermediate rumpless type, these two vertebrae seem to be present regularly in complete (hereditary) rumplessness. In accidental rumplessness, however, nothing if left of the pygostyl. In our previous report, we stated that similar protuberances occur in both types of rumplessness. As far as accidental rumplessness is concerned, this statement was based on the appearance of the skeleton shown in Figure 13 of our earlier paper. This case, however, is anomalous also in other respects (for instance, there are at least three of four vestigial caudal vertebrae left, and all the synsacro-caudal vertebrae are present), and cannot fairly be compared with the other cases of accidental rumplessness which all show the complete absence of protuberances which might represent parts of the pygostyl. With regard to the presence of remains of the pygostyl in the pelves of hereditary rumplessness, similar to those described for intermediate rumplessness, we find, therefore, a constant difference between hereditary and accidental rumplessness not noted in our earlier comparison of these two types.

We have mentioned already that one or two vertebrae are missing in

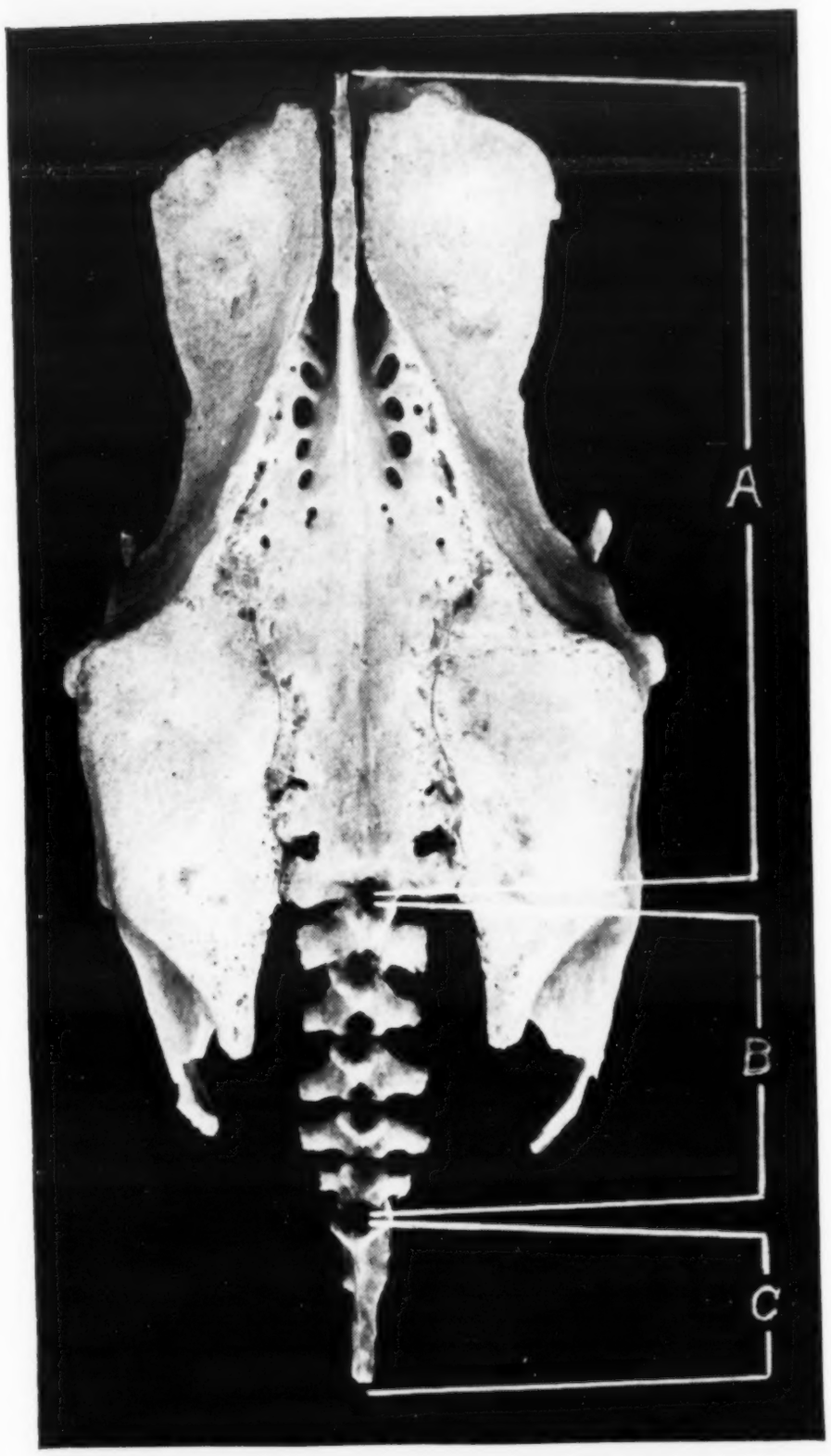


♂ 1482 ♂ 1475 ♂ 1464 ♀ 1368

PELVIC BONES OF INTERMEDIATE RUMPLESS FOWLS

Figure 2

Intermediate rumplessness is a genetic modification of complete rumplessness, from which it differs morphologically in a greater development of the tail vertebrae. The skeletons of ♂ 1482 and of ♂ 1475 show the greatest development and differentiation of the affected vertebrae of any of the intermediate rumpless skeletons studied. There is usually a higher degree of differentiation of the caudal segment in males.



TAIL VERTEBRAE OF NORMAL FOWL

Figure 3

Showing *A* synsacral vertebrae, *B* free caudal vertebrae and *C* Pygostyl. The regions marked *B* and *C* are the parts affected by the rumpless gene.

the synsacro-caudal region of the intermediate rumpless birds. Among the 23 cases observed, nine had three vertebrae, thirteen four vertebrae, and only one all five vertebrae in the synsacro-caudal region. The distribution of the pelves with only three synsacro-caudal vertebrae suggests that there is a correlation between the size and degree of differentiation of the free caudal segment of the vertebral column and the reduction in number of synsacro-caudal vertebrae. Among the twelve first cases of our series we find only three with three synsacro-caudel vertebrae, whereas there are six pelves of this type among the last eleven skeletons. It seems then that the greater reduction in the caudal segment is associated to a certain degree with a smaller number of vertebrae in the synsacro-caudal region. On the other hand, however, our data show that this correlation cannot be attributed to sex, since the distribution of males and females is about equal among the birds with three (4 ♂ ♂, 5 ♀ ♀) or four (7 ♂ ♂, 6 ♀ ♀) synsacro-caudal vertebrae, respectively. It is clear from the tabulation of our material that sex is not the only factor responsible for the amount of differentiation in the caudal region, and it must be one of the other factors governing the differentiation which at the same time influences the number of synsacro-caudal vertebrae.

In the normal fowl there are five vertebrae in the synsacro caudal region. Du Toit has given an exact description of these vertebrae. The most important distinction between the different synsacro-caudal vertebrae is to be found in the shape and direction of their lateral processes. The processes of the first and second vertebrae extend at an angle of about 60° towards the ilium. Those of the first vertebra are slightly broadened where they unite with the ilium, whereas the processes of the second vertebra are much broader at both ends. The processes of the third vertebra take a less caudad direction (70°), and are still broader than those of the foregoing vertebra. The processes of the last two vertebrae are very broad and connect perpendicularly the bodies of the vertebrae with the ilium. Sometimes the processes of the last vertebra end free. These differences between the processes of the normal synsacro-caudal vertebrae can be seen in Figure 9 of our previous publication (this Journal, vol. 16, p. 155).

Using these characteristics for landmarks, we have attempted to determine for every one of the skeletons which

Intermediate rumplessness is a genetic modification of complete rumplessness. The greatest development and differentiation of the affected vertebrae of the tail vertebrae. The skeletons of ♂ 1482 and of ♂ 1475 show the higher degree of differentiation of the caudal segment in any of the intermediate rumpless skeletons studied. There is usually a h

of the synsacro-caudal vertebrae are missing. As can be seen from the table, the first, fourth, and fifth vertebra are present in all cases. The third vertebra apparently always is the first one to be suppressed and the second vertebra is the next one to follow.

For comparison, we have studied the skeletons of twenty-one birds with complete hereditary rumplessness. We have found the following distribution:

2 (both ♂ ♂) with 5 synsacro-caudal vertebrae
13 (3 ♂ ♂, 10 ♀ ♀) with 4 synsacro-caudal vertebrae
6 (4 ♂ ♂, 2 ♀ ♀) with 3 synsacro-caudal vertebrae

In all cases in which there were less than five vertebrae the third one was missing. There was some variability with regard to the second vertebra to be suppressed; in four cases it appeared to be the fourth, in one case the second, and in one case the first vertebra. The observations by du Toit are in agreement with our results. He reports that the first synsacro-caudal vertebra does not show any essential deviation from the normal condition, and that the second and third vertebra show "in ihren Querfortsätzen ungefähr die gleichen Verhältnisse wie der 4. und 5. des normalen Beckens". Finally we have examined the skeletons of seven chickens with accidental rumplessness; of these skeletons six had three and one four synsacro-caudal vertebrae. In all cases where three vertebrae were present the two last ones appeared to be missing and in the one case with four vertebrae the fifth was absent. This constitutes another regular difference between the two types of hereditary and accidental rumplessness which we had not noticed in our previous comparison.

It might be questioned, of course, whether we are justified in homologizing the synsacro-caudal vertebrae in rumpless and intermediate rumpless birds with the vertebrae of the normal skeleton. The investigations of du Toit have demonstrated convincingly that the vertebrae missing in rumpless birds are absent from the beginning of embryonic development, and since the condition in the synsacro-caudal region of the pelvis in the rumpless and intermediate rumpless types is essentially the same, we may assume that here also the number of vertebrae is reduced from the beginning of differentiation. Hence we are justified in asking which vertebrae were eliminated. The shape and direction of the lateral processes of the vertebrae might depend, of course, upon the position of the vertebrae relative to the ilium; i. e., there might exist a determinative influence of the ilium upon the differentiation of the vertebral processes. The fact, however, that the pelves of accidental and of hereditary rumpless birds are distinctly and constantly different in the appearance of the lateral processes of the vertebrae in this region speaks against such an assumption. In the case of accidental rumplessness, one has to assume that by some mechanical action the differentiation of the caudal end of the vertebral column was prevented. Naturally, then, we would expect that posterior to a certain point the skeletal elements are missing. This, indeed, is what we find. If in the accidental type the processes of the first three synsacro-caudal vertebrae preserve their characteristics, there is no reason why the same should not apply to the hereditary type, and this seems to justify the homologizing of the vertebrae according to the appearance of their processes. Another observation pointing in this direction is the fact that in pelves (of normal or intermediate rumpless fowls) in which the last synsacro-caudal vertebra is free, no change occurs in the shape and arrangement of the remaining vertebrae connected with the ilium. Further proof to the same effect was provided by the examination of the pelves of day-old rumpless and intermediate rumpless chicks. At this stage the vertebrae of the

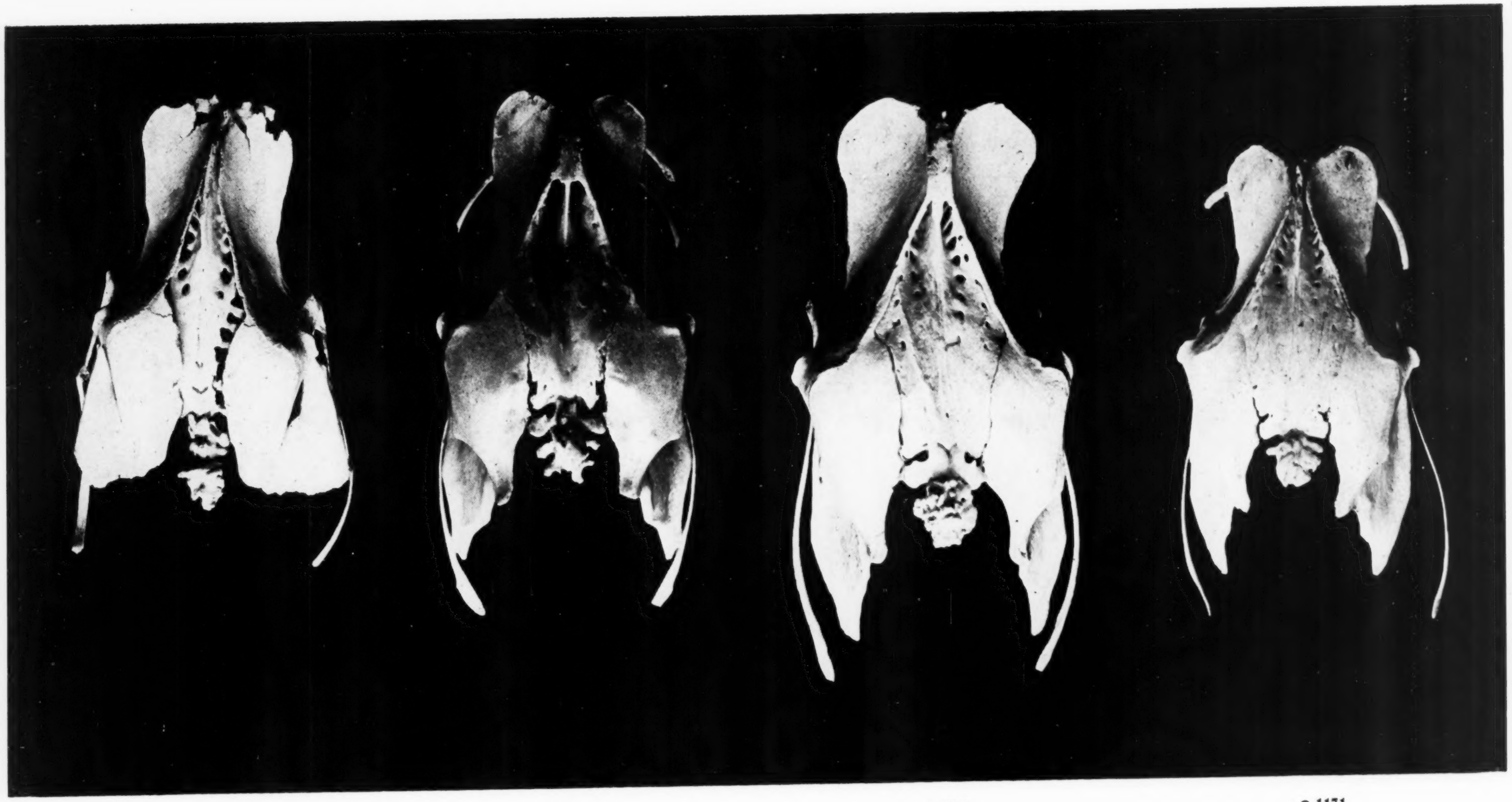
synsacro-caudal region in the normal chick differ from each other in a typical and constant fashion by the degree of ossification and fusion of the bodies of the vertebrae at the dorsal surface. An examination of twenty of such pelves of rumpless and of fourteen of intermediate rumpless chicks confirmed the results obtained with the adult animals. Wherever the number of the synsacro-caudal vertebrae was reduced by one the third vertebra appeared to be missing. The important point in this case is the fact that at this stage of development the vertebral processes and the ilium are still independant and a formative influence of the latter upon the differentiation of the lateral processes of the vertebrae is unlikely to have occurred. It is true, however, that at this stage the synsacro-caudal vertebrae and the remains of the pygostyl of the rumpless and intermediate rumpless birds are somewhat larger than those of the normal chick, and this increase in size appears to be distributed evenly over the whole synsacro-caudal region. We must conclude then that a relatively larger amount of cartilage is at the disposal of the individual centers of vertebral differentiation if the number of these centers is reduced. In the adult skeleton, however, no size difference is perceptible between the vertebrae of the hereditary and intermediate rumpless birds and those of the normal.

The morphological difference in the synsacro-caudal vertebrae of the hereditary and the accidental rumpless skeletons and the evidence derived from young chicks seems to prove then that in the case of complete and intermediate (hereditary) rumplessness vertebrae have been suppressed in the synsacro-caudal region and in the frontal part of the pygostyl. There has been much discussion in the literature of comparative anatomy concerning the question whether in animals with a different number of vertebrae the vertebrae with the same ordinal number are homologous (Rosenberg) or whether segments of the vertebral column must be homologized (Welcker, du Toit). Du Toit has discussed in detail why it is impossible to assume with Rosenberg that vertebrae with the same ordinal number are homologous. On the other hand, the hypothesis that corresponding segments of the vertebral column are homologous, only helps in understanding the evolutionary changes in the number of vertebrae if we have reason to believe that excalations (discontinuous suppressions) of vertebrae have taken place in the different segments during this process. Berg in his careful study of the reductions of the vertebral column in short-tailed cats and dogs comes to the following final conclusion:

> Dagegen halte ich es nicht für erlaubt, ohne weitere Stützen gefunden zu haben, anzunehmen, dass diskontinuierliche Reduktionsvorgänge wie wir sie für die Schwanzwirbelsäule nachgewiesen haben, auch für andere Abschnitte der Wirbelsäule Bedeutung und Wirksamkeit haben könten und damit in die Diskussion über deren phylogenetische Entwicklung enzutreten. Wenn embryonal angelegte, aber wieder zur Rückbildung kommende Organe, die eine relative grosse Längsausdehnung haben, wie z. B. der Schwanzdarm beim Menschen, reduziert werden, dann tritt der Rückbildungsprozess nicht nur am Ende, sondern auch an anderen Stellen des Verlaufs diskontinuierlich ein und für einige Zeit persistieren strangförmige Reste. Die Reduktion des Schwanzes bei unserem Material scheint prinzipiell ähnlich beurteilen zu sein, nur dass die unbekannte Ursache, welche die Reduktion hervorruft, nicht so stark wirksam ist, dass ein vollständiges Verschwinden entreten könnte.

We believe that our material provides proof that reductions in the number of vertebrae by excalation may take place in segments of the vertebral column anterior to the caudal region, and it appears likely that the reduction from six caudal vertebrae in *Gallus bankiva* (Shufeldt) to five in the domestic fowl has taken place by a similar process.

Our material demonstrates the occurence of two different processes: 1, the discontinuous suppression (excalation) of vertebrae in the synsacro-



♀ 4887 ♀ 1358 ♂ 1210 ♀ 1171

INTERMEDIATE DEVELOPMENT OF SYNSACRAL VERTEBRAE

Figure 4

The more the reduction in the caudal segment of the vertebral column progresses the more frequently fusions occur of two or more lateral processes of the vertebrae, and the less well differentiated are the spinal processes on the dorsal surface of the vertebrae. In pelves with as much or more reduction in the caudal region of the vertebral column as is the case with ♀ 4887 and ♀ 1358 no free caudal vertebrae occur. The spinal processes usually are missing; the lateral processes are very short and frequently in an irregular position.

♀ 1356

♀ 4647

EXTREME CASES OF FUSED VERTEBRAE

Figure 5

These are the two cases showing the greatest degree of reduction and fusing of vertebrae. In the most extreme case (♀ 4647) the presence of only three caudal vertebrae can be established with certainty.

caudal region and in the anterior part of the pygostyl in both rumpless and intermediate rumpless birds; and 2, the shortening of the caudal part of the vertebral column by fusion of all or at least the three last caudal vertebrae in the intermediate rumpless chickens. The discontinuous disappearance of vertebrae has been observed by Berg and others in the tail of short-tailed cats and dogs, and these animals also show a more or less pronounced fusion of caudal vertebrae comparable in many respects to the one observed by us. A similar disappearance of tail vertebrae seems to occur in mice (Dobrovolskaia-Zavadskaia). A discontinuous disappearance of vertebrae, however, in regions anterior to the caudal segment of the vertebral column apparently has not been observed before, and it would be of considerable interest to know whether analogous processes take place in connection with the tail reduction in other animals.

This discontinuous disappearance of vertebrae suggests that there are in the vertebral column places of predilection in which the agencies tending towards reduction of the tail operate preferentially. In these places (synsacro-caudal region and anterior part of pygostyl) we have only seen either presence or absence of the vertebrae, but no fusion or incomplete differentiation of vertebrae as it is found in the segment of free caudal vertebrae. Neither our morphological observations nor our breeding data, however, sustain the hypothesis advanced by Dobrovolskaia-Zavadskaia for her mouse material that there are independent factors governing the development of single vertebrae and their parts. Perhaps it is more likely that some regions respond discontinuously to quantitative differences in gene material, resulting in a differentiation of the "all-or-nothing" type, whereas other regions respond directly to the presence of a certain amount of gene material with a correspondingly large amount of differentiation.

From the phylogenetic standpoint it is interesting that a reduction of the number of vertebrae by excalation and suppression should be definitely inherited, thus making possible the appearance of races differing discontinuously in the number of vertebrae in homologous segments of the vertebral column. From a genetic standpoint it is significant that separate parts of the vertebral column are suppressed by the action of the rumpless gene, and that one of these parts (the free caudal segment) may reappear in a modified condition under the influence of other genetic agencies.

Summary

The chief conclusions to be drawn from our observations are as follows:

1. In the domestic fowl exists an intermediate rumpless condition.

2. In intermediate rumpless chickens one or two vertebrae of the synsacro-caudal region and all the vertebrae forming the pygostyl except the last two are absent.

3. The five free caudal vertebrae, perhaps with the exception of the two most reduced cases, are all present. The degree of differentiation of these vertebrae is extremely variable, and it is chiefly this variability that is responsible for the existence of a graded series leading from an almost normal to an almost rumpless appearance of the pelvis. In all cases, however, the intermediate condition is clearly differentiated from the rumpless type by the presence of free caudal vertebrae and from the normal type by the absence of vertebrae in the synsacro-caudal region and in the pygostyl and by the fusion of caudal vertebrae.

4. Arranged according to size and differentiation of the caudal part of the vertebral column, the series leads from pelves in which the first two caudal vertebrae are more or less normal and only the last three fused to such pelves in which all caudal vertebrae are fused completely, and in the most extreme case only traces of three vertebrae can be distinguished, although all five may have gone into the fusion.

5. Sex has an important influence upon the growth and differentiation of the caudal vertebrae; the males usually have a longer and better differentiated caudal region.

6. The number of vertebrae (three or four) in the synsacro-caudal segment of the intermediate rumpless birds is not influenced by the sex. Since there are more cases, however, with only three synsacro-caudal vertebrae among the pelves with a greater reduction of the caudal part of the vertebral column another factor influencing size and degree of differentiation of the caudal vertebrae at the same time must tend to reduce the number of synsacro-caudal vertebrae to three.

7. A comparison of the intermediate rumpless, the hereditary, and the accidental rumpless condition shows that in the case of accidental rumplessness all vertebrae posterior to the third (or in rare cases the fourth) synsacro-caudal vertebrae are suppressed, whereas in the hereditary types (intermediate and complete) one or two vertebrae are missing in the center of the synsacro-caudal region and the four or five first vertebrae forming the pygostyl (in complete hereditary rumplessness, of course, the five free caudal vertebrae are missing in addition). This shows that excalations of vertebrae may take place in a segment of the vertebral column without affecting the normal appearance of the remaining vertebrae in this region.

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TABLE I—Data Regarding the Number and Arrangement of the Caudal Vertebrae of 23 Adult Intermediate Rumpless Fowls

Number of bird	Sex	Number of synsacro-caudal vertebrae present	Missing synsacro-caudal vertebrae in order of normal condition	Number of caudal vertebrae present	Number of unfused caudal vertebrae	REMARKS
1482	♂	4	3.	5	2	First two caudal vertebrae essentially normal; dorsal spinal processes of the second slightly asymmetrical, lateral processes much reduced in size. The three last caudal vertebrae and pygostyl fused irregularly. Fig. 2.
1475	♂	3	2. and 3.	5	1	Last syns.—caud. vertebra free. Second caud. vert. fused with third. Proc. spin. dors. of second slightly asymmetrical. Left lat. proc. of third vert. fused with body of second. Third vert. much reduced in size. Fourth and fifth vert. irregularly fused with pygostyl. Proc. spin. dors. of last two vert. visible as small knobs; lateral proc. of the two vertebrae fused. Fig. 2.

TABLE I—Data Regarding the Number and Arrangement of the Caudal Vertebrae of 23 Adult Intermediate Rumpless Fowls

Number of bird	Sex	Number of synsacro-caudal vertebrae present	Missing synsacro-caudal vertebrae in order of normal condition	Number of caudal vertebrae present	Number of unfused caudal vertebrae	REMARKS
1464	♂	4	3.	5	1	The last syns.-lumbar vert. has a diapophysis on the right side. The last syns.-caud. vert. is free. Lat. proc. of syns. caud. vert. broad. Lat. proc. of first caud. vert. slightly asymmetrical; there is an irregular caudad protuberance on the left side of the body of the vert. The second to fifth caud. vert. and pygostyl fused. Between third and fourth caud. vert. the line of fusion still visible. The bodies and proc. spin dors. of second and third caud. vert. entirely fused; the left lat. proc. independant, the right ones connected with each other by a small bony trabeculum. Lat. proc. of fourth caud. vert. split. Fig. 2.
1476	♂	4	3.	5	0	All caud. vert. and pyg. fused. Traces of the proc. spin. dors. of at least four vert. visible; dorsally all vert. fused plate-like with small protuberances representing the spin. proc. Between third and fourth vert. line of fusion ventrally still visible. Left lat. proc. of the first three vert. partially fused, the left proc. of fourth vert. is small and directed downward, that of the last vert. directed backward. Right lat. proc. of first vert. free; proc. of second to fourth vert. partially fused with each other; that of the fifth directed downward.
1481	♂	4	3.	5	1	The last syns.-caud. vert. free and fused with first caud- vert.; line of fusion still visible. Left lat. proc. of both vert. normal; right lat. proc. of first caud. vert. missing. The second to fifth caud. vert. and pyg. fused. Lat. proc. of last four caud. vert. partially fused with each other; some directed downward, others only present as small protuberances. Pygostyl slightly out of normal position.
5634	♀	4	3.	5	0	Last syns.-caud. vert. free. Three first caud. vert. fused with each other; only the third has well differentiated proc. spin. dors. There are three lat. proc. on the right side but only one on the left. Fourth and fifth caud. vert. fused irregularly with pyg. Fourth vert. has small proc. spin dors., the fifth none. Lat. proc. of last two vert. small and in irregular position.

TABLE I—Data Regarding the Number and Arrangement of the Caudal Vertebrae of 23 Adult Intermediate Rumpless Fowls

Number of bird	Sex	Number of synsacro-caudal vertebrae present	Missing synsacro-caudal vertebrae in order of normal condition	Number of caudal vertebrae present	Number of unfused caudal vertebrae	REMARKS
1470	♂	3	2. and 3.	5	0	Identification of missing syns.-caud. vert. somewhat doubtful. All caud. vert. and pyg. fused together. Line of fusion still visible between second and third vert. Only traces of proc. spin. dors. Right lat. proc. of first four well differentiated though short, of fifth small and pointing downward. Left lat. proc only visible as small protuberances.
5409	♂	4	3.	5	0	First caud. vert. dorsally fused with others; its proc. spin dors. short and irregular; lat. proc. normal. Second to fifth caud. vert. and pyg. fused irregularly; traces of three pair of proc. spin. dors. Left lat. proc. of second to fourth vert. partially fused; the same is true for right proc. of third and fourth. Lat. proc. of last vert. short and pointing downward.
1729	♀	3	2. and 3.	5	0	First and second caud. vert. free dorsally but fused ventrally; second and third fused dorsally but free ventrally. Proc. spin. dors. of third small and slightly irregular. Body of third vert. united with the irregularly fused fourth and fifth and pyg. Last two vert. show traces of proc. spin. dors. and lat. proc. without free differentiation.
1471	♂	4	2. or 3.	5	0	The second vert. present in syns.-caud. region very broad. All caud. vert. and pyg. fused irregularly. Left lat. proc. of first two vert. fused, of last three vert. only present as small displaced knobs. Right lat. proc. of first vert. free of second to fourth partially fused, of fifth small and situated on ventral surface of vert. Proc. spin. dors. all very small and irregular . Pyg. displaced towards right side.
1368	♀	4	3.	5	1	Last syns.-caud. vert. free, its right lat. proc. only short knob. First caud. vert. free, its right lat. proc. very short. Second to fifth caud. vert. and pyg. fused. Traces of proc. spin. dors. can be seen. On left side two lat. proc. present of which posterior seems to be fused out of three; on right side only one lat. proc. visible. Fig. 2.
1395	♂	4	3.	5	0	Only traces of proc. spin. dors. visible. On left side five lat. proc. of which the third and fourth fused, the fifth on ventral side. On right side two lat. proc., both of which seem to represent two each.

TABLE I—Data Regarding the Number and Arrangement of the Caudal Vertebrae of 23 Adult Intermediate Rumpless Fowls

Number of bird	Sex	Number of synsacro-caudal vertebrae present	Missing synsacro-caudal vertebrae in order of normal condition	Number of caudal vertebrae present	Number of unfused caudal vertebrae	REMARKS
1727	♀	4	3.	5	0	Last syns.-caud. vert. free. All caud. vert. and pyg. fused irregularly. Four pair proc. spin. dors. visible as very small knobs. Lat. proc. of first three vert. very broad, partially fused; of last two vert. very small and irregularly situated.
4887	♀	4	3.	5	1	Last syns.-caud. vert. free. First caud. vert. free, essentially normal. Second to fifth caud. vert. and pyg. very irregularly fused. Proc. spin dors. of second and third mising, of fourth and fifth present as small irregular knobs. Lat. proc. of all four fused vert. visible but not freely differentiated. Fig. 4.
1358	♀	4	3.	5	0	Last syns.-caud. vert. free. On fused caud. portion traces of proc. spin. dors. only visible at the anterior and posterior end. Traces of lat. proc. of all vert. present, but some only small knobs. Lat. proc. of last two vert. partially fused; one pair on either side of caudal end of vertebral column. Fig. 4.
1210	♂	3	2. and 3.	5	0	All caud. vert. and pyg. irregularly fused. Only traces of first two pair of proc. spin. dors. present, others missing. Very short lat. proc. of first four vert. present on both sides. Lat. proc. of fifth vert. forming short protuberances on ventral surface of fused bone. Fig. 4.
6406	♀	5	—	5	0	Last syns.-caud. vert. free. All five caud. vert. and pyg. fused. Proc. spin. dors. of first vert. relatively well differentiated, of second present as small knobs, of others missing. Left lat. proc. of all five vert. present, caudadly decreasing in size; right lat. proc. also all present but very irregular in size and shape.
6536	♂	3	2. and 3.	5	0	Last syns.-caud. vert. free. All five caud. vert. fused very irregularly. Proc. spin. dors. of all five vert. present as small knobs. Left lat. proc. of all five vert. present, partially fused with each other. Only three lat. proc. on right side, all very short and irregular. Pyg. not yet fused with caud. vert.; asymmetrically situated. Skeleton of very young bird with incomplete ossification.
6521	♀	4	3.	5	0	Last syns.-caud. vert. free. All five caud. vert. and pyg. fused very irregularly. Scarcely any traces of proc. spin. dors., except of first vert. Left lat. proc. all present. Right lat. proc. of second and third vert. fused. Pyg. forming small protuberance on ventral surface.

TABLE I—Data Regarding the Number and Arrangement of the Caudal Vertebrae of 23 Adult Intermediate Rumpless Fowls

Number of bird	Sex	Number of synsacro-caudal vertebrae present	Missing synsacro-caudal vertebrae in order of normal condition	Number of caudal vertebrae present	Number of unfused caudal vertebrae	REMARKS
1707	♀	3	2. and 3.	5	0	All five caudal vert. and pyg. fused very irregularly. Proc. spin dors. of first vert. present as small knobs. In region of third and fourth vert. spinal canal open dorsally. Lat. proc. of all vert. present as small and irregularly located protuberances. Pyg. small knob, dislocated towards right dorsal side. In this and following skeletons end of vertebral column does not reach the caudal end of ilium.
1171	♀	3	2. and 3.	5	0	All caud. vert. and pyg. fused very irregularly. Proc. spin. dors. absent. Lat. proc. of first vert. free, of others forming short and irregular knobs. Fig. 4.
1356	♀	3	2. and 3.	5(?)	0	Probably all five caud. vert. and pyg. fused. Fusion extremely irregular. No proc. spin. dors. Lat. proc. of at least four vert. visible; two, and possibly three, pair of lat. proc. located on ventral surface of fused bone. Fig. 5.
4647	♀	3	2. and 3.	?	0	Lat. proc. of the last two syns.-caud. vert. on right side entirely fused. Fusion of caudal part represents small bone without differentiation of proc. spin. dors., but with traces of the lat. proc. of at least three vertebrae. Fig. 5.

EARLY SELECTION OF THE TEUTONIC RACE

(*Continued from page* 437)

fallow, and more or less restored to its original fertility; and so begins a period of rapid and prosperous increase. In no other way can I explain the rate at which nations after the most desolate wars spring up, young and strong again, like the phoenix, from their own funeral pile. They begin afresh as the tillers of a virgin soil, fattened too often with the ashes of burnt homesteads, and the blood of the slain.

Another element of comfort may have been the fact, that in the rough education of the forest, only the strong and healthy children lived, while the weakly died off young, and so the labour-market, as we should say now, was never overstocked. This is the case with our own gipsies, and with many savage tribes—the Red Indians, for instance—and accounts for their general healthiness: the unhealthy being all dead, in the first struggle for existence. But then these gipsies and the Red Indians, do not increase in numbers, but the contrary; while our forefathers increased rapidly. On the other hand, we have, at least throughout the middle ages, accounts of such swarms of cripples, lepers, deformed, and other incapable persons, as to make some men believe that there were more of them, in proportion to the population, than there are now. And it may have been so. The strongest and healthiest men always going off to be killed in war, the weakliest only

would be left at home to breed; and so an unhealthy population might spring up. And again—and this is a curious fact—as law and order enter a country, so will the proportion of incapables, in body and mind, increase. In times of war and anarchy, when every one is shifting for himself, only the strongest and shrewdest can stand. Woe to those who cannot take care of themselves. The fools and cowards, the weakly and sickly, are killed, starved, neglected, or in other ways brought to grief. But when law and order come, they protect those who cannot protect themselves, and the fools and cowards, the weakly and sickly, are supported at the public expense, and allowed to increase and multiply as public burdens. I do not say that this is wrong. Heaven forbid! I only state the fact. A government is quite right in defending all alike from the brute competition of nature, whose motto is—Woe to the weak. To the church of the middle age is due the preaching and the practice of the great Christian doctrine, that society is bound to protect the weak. So far the middle age saw; but no further. For our own times has been reserved the higher and deeper doctrine, that it is the duty of society to make the weak strong; to reform, to cure, and above all, to prevent by education, by sanitary science, by all and every means, the necessity of reforming and of curing. (Pp. 232-235.

The warfare of organized nations undoubtedly is more dysgenic than unorganized primitive warfare, since those with greater strength, energy and courage are more likely to be killed. Also in primitive times the incapables, if not massacred or enslaved, usually were doomed by starvation and disease. Raids and reprisals often were continued till hostile tribes were "all but exterminated", thus making room for rapid increase from select groups of survivors, as Kingsley suggests. Even in modern times, sieges, famines and plagues have been the usual incidents of war, and no doubt have continued their selective functions. Only the most advanced nations are able at the same time to conduct war, control disease and prevent starvation, so that all of the primitive limitations on the increase of the less capable elements of the population are removed. Meanwhile, scholastic education and other social agencies are operating to restrict the reproduction of the more capable elements, so that a gradual impairment of racial ability must be expected unless these tendencies can be changed.

Chromosome Duplication in Sugar-Cane Hybrids

In an effort to produce sugar-cane varieties resistant to mosaic diseases a number of breeding projects have been under way in the East Indies. G. Bremer reports on the cytology of some of the hybrids of the *Saccharum officinarum* and S. *spontaneum* in *Archief voor de Suckerindustrie in Nederlandsch Indie*. His results are abstracted in *Nature* (London) as follows:

S. officinarum has 40 chromosomes (haploid) and *S. spontaneum* 56, while the F_1 of the cross between them had 136. The author concludes that the additional 40 chromosomes originated by the longitudinal splitting of the maternal (*S. officinarum*) chromosomes during fertilisation. The F_2 plants in general resembled those of the F_1 generation. Back-crosses of *S. officinarum* and F_1 plants had 148 chromosomes, indicating that the haploid number of the former had doubled again during fertilisation. It was by crossing these back-crosses again with *S. officinarum* that plants were obtained of high value for cultivation and resistant to both "sereh" and mosaic. The somatic chromosomes of plants from this crossing varied in number from 106 to 120. A hybrid of *S. officinarum* and a variety of *S. spontaneum* from North Celebes again showed an increase of 40 chromosomes, presumably through the splitting of the *S. officinarum* chromosomes. There is some evidence that the size of the plants in *Saccharum* is dependent on the chromosome number. Some of the new sugar-canes, with about 57 as the haploid chromosome number, obtained in the above experiments were crossed again with *S. spontaneum*. From these crosses robust plants were obtained with about 170 chromosomes in the somatic cells. Though these hybrids are useless for cultivation, it is suggested that recrossing them with the best varieties of *S. officinarum* might result in some hybrids of high value with very high chromosome numbers.

BUD SELECTION IN THE WASHINGTON NAVEL ORANGE

VIII. Progeny Tests of Two Color Variations—Yellow and Golden Nugget

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THE description of a number of striking bud variations of the Washington Navel orange and a discussion of their relation to the origin and development of some important strains of this variety have been presented in an earlier publication.[1]

The performance-records of progeny trees of several limb variations of the Washington Navel orange have also been published,[2] proving that limb variations showing differences in the quantity and quality of fruit production are capable of perpetuation through bud propagation. In the following pages two color variations of the Washington Navel orange will be described and performance record data will be presented which has been secured from progeny trees which have been propagated from several limbs and trees of these strains.

The Yellow Strains

Two yellow strains have been studied in these investigations, viz., the Yellow Washington and the Yellow Thomson, the former occurring as bud variations of the Washington and the latter as bud variations of the Thomson strain, respectively. Both are distinguished from the parent strains mainly by reason of the yellow color of their fruits as contrasted with the typical orange or reddish-orange colored fruits produced by the parent strains and from the fact that the trees of the Yellow strains have been found to be less productive than comparable trees of the parent strains. A brief description of some of the characteristics of typical trees and fruits of each of the Yellow strains will be presented in order to aid in a clear understanding of the basis of these progeny tests.

Trees of the Yellow Washington strain are somewhat erect in their habit of growth, and their foliage is rather sparse. The leaves are relatively small, slightly pointed in shape and light green in color.

The fruits of this strain are similar in shape, size, thickness of rind and abundance of oil cells to those of the Washington strain, but their color is strikingly different, being a light yellow with characteristic small red stripes, or blotches, which are somewhat like those found on Golden Nugget fruits. The characteristics of the rag and juice are similar to those of the Washington strain, except that the fruits tend to ripen a little earlier, the juice is slightly less acid, and the flesh is somewhat lighter in color.

The trees and fruits of the Yellow Thomson strain possess similar relative differences from the trees and fruits of the normal Thomson strain, as is the case with the Yellow Washington and normal Washington strains. The yellow color of the fruits and their red stripes or other markings serve to distinguish the Yellow Thomson fruits from the true Thomson oranges in an unmistakable manner. The ripe fruit and foliage characteristics of both the Yellow strains are such as to render their identification certain whether they occur as individual fruit variations, as limbs, or as entire trees.

At the time when these investigations were first undertaken some growers were of the opinion that the Yellow strains and the Yellow Wash-

ington strain in particular were of special commercial value. A limited propagation of the Yellow Washington strain was made by at least one nurseryman for orchard planting. Individual tree performance-record studies of comparative full-bearing Yellow Washington and normal Washington trees demonstrated that the trees of the Yellow strain were consistenly less productive than those of the true Washington strain and as a result the further commercial propagation of the Yellow Washington strain was abandoned. Most of the trees of both the Yellow Washington and Yellow Thomson strains in established orchards have now been top-worked to the normal Washington strain.

Limb and Tree Variations of the Yellow Strains

Limb variations bearing fruit typical of the Yellow strains have been found in otherwise normal Washington and Thomson trees grown from a single bud in all of the orchards of these strains where individual tree performance-record work has been carried on. In some instances these limb variations have been of small size; producing only a few fruits each year while in other cases they have been large and have produced many typical yellow fruits. Not only the fruits but the size, shape and color of leaves on these limb variations have shown the typical characteristics of the Yellow strains.

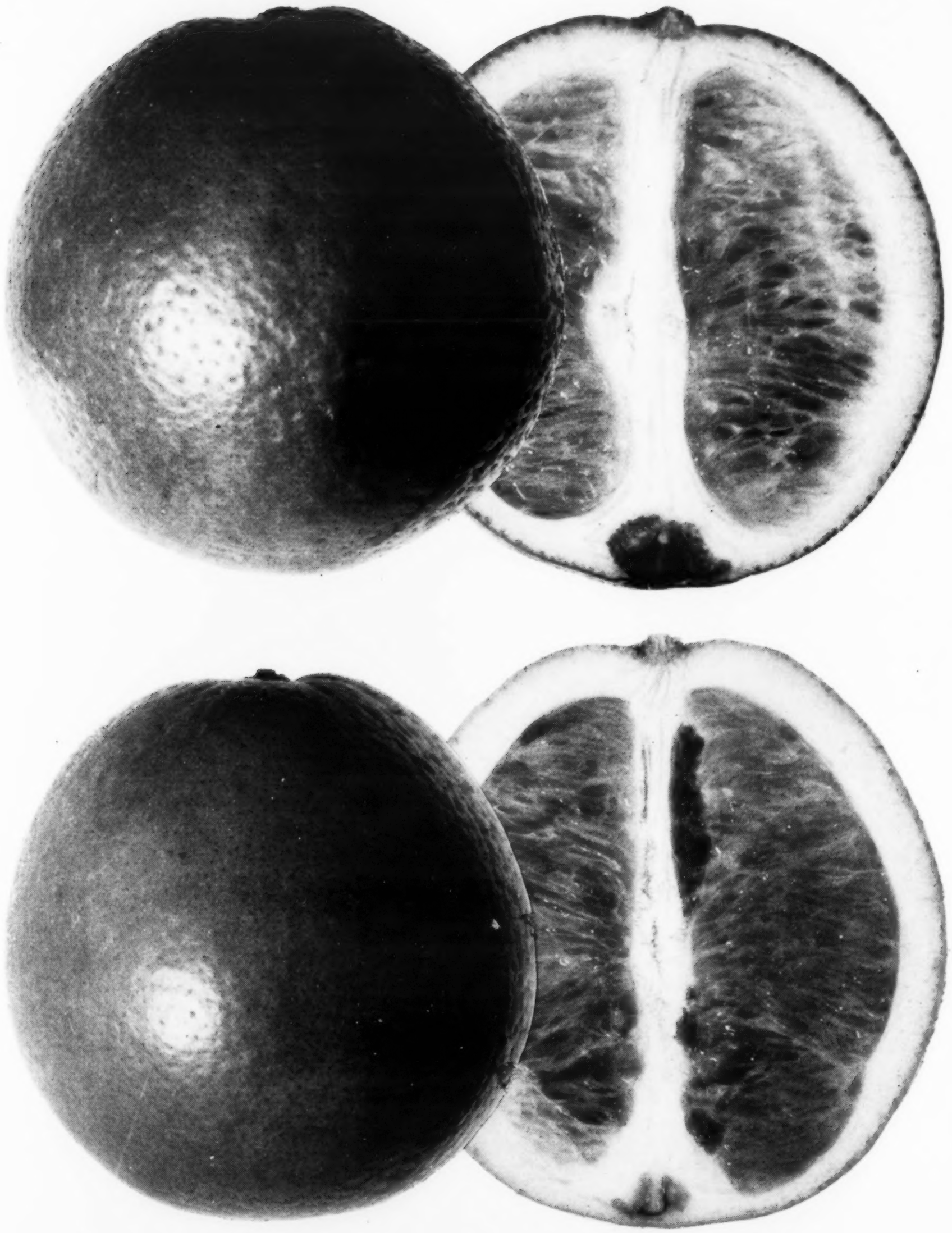
Entire trees of the Yellow strains have also been found occasionally in the orchards where the Yellow limb variations were discovered. It is probably that these entire tree variations in established orchards resulted from the accidental cutting of budwood from limb sports of the Yellow strain which were present in the parent Washington or Thomson trees from which the orchard trees were propagated. This condition is similar to the origin of many of the important diverse strains which have been studied in the citrus orchards in the Southwest during recent years.

Progeny Propagations

Budwood was secured in the spring of 1915 from five typical Yellow limb variations in five Thomson parent trees found in the Victoria, Vivienda and Eureka orchards of the National Orange Company at Riverside, California. Budwood was also cut from normal branches of three of the parent trees in which the limb variations were discovered. These buds were propagated on sour orange seedlings in a commercial nursery and the resulting trees were transplanted to the progeny orchard of the Citrus Experiment Station of the University of California at Riverside on July 2, 1917. The performance-records of the progeny trees grown from these propagations are shown in Table I. Fruits from one of these progeny trees are shown in Figure 6.

In the A. W. Miller Washington Navel orange orchard on the Church tract at Riverside, California, a considerable number of Yellow Washington strain trees were found, all of which were supposed to be of the Washington strain. After observing the fruiting habits of some of these Yellow Washington trees for several years in order to determine whether or not they produced typical Yellow fruits consistently from year to year, budwood was secured from four of them and the buds were propagated on sour orange seedlings in a commercial nursery in the spring of 1916. The resulting trees were set in the progeny orchard of the Citrus Experiment Station during the spring of 1919. The performance-records of these progenies and those of similar progenies of parent trees of the Washington strain are shown in Table II.

In the Sunny Mountain orchard near Riverside, California, where one of the first individual-tree performance-record plats was located a number of Yellow Washington strain



THOMSON AND YELLOW FRUITS

Figure 6

Above are shown fruits from a progeny tree from the normal part of a Thomson tree having a branch which bore yellow fruits. Below are shown fruits from a progeny tree propagated from this mutant limb. The characteristics of the Yellow strain have consistently been perpetuated in the progeny trees.

trees and Yellow limb sports in Washington strain trees were studied during the period of 1911-12 to 1914-15 inclusive. The history of this planting according to the late Mr. L. V. W. Brown, manager and part owner, indicates that the Yellow Washington trees, about 300 in number, had been top-worked on Washington strain trees with budwood secured from Yellow limb variations in some of the Washington trees in this same orchard. The top-working was done a few years after the original planting and the trees were about 12 years old when the individual-tree records were begun, the top-worked trees being in full bearing at that time. The yields of the 13 Yellow Washington strain trees in the performance-record plat, for the period 1911-12 to 1914-15 inclusive are shown in Table III. The production of 13 comparable Washington strain trees in the same plat is also shown. Continued observations in this plat confirmed the conclusion derived from these data that the Yellow Washington strain trees were much less productive than those of the normal Washington strain. As a result all the Yellow Washington strain trees were top-worked in 1923 with buds secured from desirable Washington trees, excepting three trees which were left for further study.

Progeny Performance Records

As shown in Table I the average total yield for the 10 progeny trees of the Yellow Thomson trees has been 969 oranges per tree while the average total yield of the 9 Thomson trees has been 1472 fruits per tree. It is evident that the yield of the Yellow Thomson progeny trees has been much less than the production of the normal Thomson progeny trees.

The performance records also show that the progeny trees of the Yellow limb variations have produced consistently typical Yellow Thomson strain fruits except in the crop of progeny tree 17 for the season 1922-23, when one fruit was classified as belonging to the Washington strain. The progeny trees propagated from the normal Thomson branches on the same parent trees have borne exclusively Thomson fruits during the performance record period except that in the case of progeny tree 15 one fruit was recorded in the 1924-25 crop as having yellow sections.

In Table II the records of nine progeny trees which were propagated from four different entire-tree variations of the Yellow Washington strain are compared with the records of four Washington strain progeny trees for a seven-year period. The total average production of the 9 Yellow Washington strain trees has been 608 oranges while for the 4 normal Washington trees the total average yield has been 758 oranges, or a somewhat larger yield for the Washington strain progeny trees. The fruits from the Yellow Washington strain trees have all been typical of this strain except in the five cases that are noted.

The average 4-year yields of the 13 Yellow Washington top-worked trees was 1,100 oranges. All of the fruits produced by these trees were typical of the Yellow Washington strain except a few oranges having sections showing normal Washington rind characteristics as noted in the table.

During the same period performance records were obtained of 13 normal Washington trees which were comparable to the top-worked Yellow trees. It will be seen that the total average yield was 1,805, or 705 more than the total average of the Yellow Washington trees for the same period (Table III). The weight of fruits is not given in Table III, but the average annual weight of crop produced by the 13 Yellow Washington trees was 114.7 pounds and the average weight of crop for the 13 comparable Washington trees was 172.0 pounds. In this performance record plat there were a total of 71 trees of the Washington strain and they

produced an annual average of 187.9 pounds per tree per year for the period 1911-1912 to 1914-15, inclusive.

From these data it is apparent that in these progeny tests the fruit characteristics of the limb and entire-tree variations of the Yellow strain have been transmitted through bud propagation and that the yield of the Yellow strain progeny trees has been inferior to that of the progeny trees of the normal Thomson and Washington strains.

The Golden Nugget Strain

THE Golden Nugget strain has been propagated commercially to a limited extent in California and has commonly been considered as a distinct variety. In earlier studies of navel orange groves, trees of this strain were of rather frequent occurrence, but during recent years most of these trees have been topworked to the Washington strain. Some trees of the Washington strain and many Thomson trees in established orchards have been found to bear individual fruits also of this strain. Occasional limbs have been found in such trees producing typical Golden Nugget fruits consistently from year to year during the period of observation from 1909 to 1925.

The trees of the Golden Nugget strain have a characteristic appearance and habit of growth which renders their identification certain even when they occur as individual trees in the Washington Navel or Thomson strain orchards. They are usually less vigorous growers than the Washington or Thomson trees, and the branches have a drooping habit of growth with rather dense foliage. The leaves have a lighter color than comparable trees of the Washington or Thomson strains and may be described as olive green in appearance. The lighter color of the leaves, the drooping habit of growth and the usual dwarf character make these trees easily distinguishable whenever they occur.

The Golden Nugget fruits are usually elliptical or pyriform in shape and of medium to large sizes. The texture of the rinds is exceptionally smooth, but many of the oranges have slight ridges or knoblike projections. The color of the rinds is light yellow, except that any ridges or knobs are usually bright reddish orange in color. There are comparatively few oil cells in the rinds and this peculiar condition, together with their characteristic yellow color and reddish ridges or knobs serves to identify the fruits wherever found. The rag is coarse and abundant like that of the fruits of the Thomson strain and the juice is plentiful and is frequently of distinctive flavor. The fruits are seedless and have very small and usually only rudimentary navels in which the openings are nearly or entirely closed.

This strain is not considered a valuable one for commercial planting in the established citrus districts of the Southwest, and the presence of occasional trees of this strain in the existing navel orange plantings is somewhat detrimental to the value of the crops produced by these orchards. However, the striking characteristics of this strain and the easily recognized appearance of the foliage makes it an important one from the standpoint of the study of the origin and development of strains of the Washington Navel orange which arise from bud variations.

Golden Nugget Limb and Tree Variations

The parent trees of progeny trees 1, 2, 3 and 4, as listed in Table IV, were planted as Thomson trees in 1903 by the National Orange Company of Riverside, California. They were grown from single buds inserted on Mission Sweet seedling rootstocks. The

parent trees of progeny trees 5, 6, 7, 8, 9, 10 and 11, were planted as Washington strain trees by the Corona Lemon Company of Corona, California, about 1900 and were also grown from single buds inserted on Mission Sweet seedling rootstocks.

The trees in both orchards have made a normal and healthy growth and no serious climatic or other injury has affected them thus far during their entire period of growth. No top-working or any kind of rebudding has been practiced at any time on these trees. Other similar trees in the same orchards have been top-worked or given other individual tree care in order to improve the uniformity of the crops, but these typical trees have been retained untouched for further observation and study.

The parent tree of progeny trees 1, 2 and 3 was a Thomson tree in which one small limb bore typical Golden Nugget fruits as shown in Figure 7. The parent tree of progeny 4 was an entire tree of the Golden Nugget strain occurring in the same Thomson orchard and which had evidently been unintentionally propagated from a bud variation at the time that the remainder of the trees in this orchard were budded.

Budwood was secured from the Golden Nugget limb variation and from a Thomson branch on the remainder of the first parent tree and also from the entire tree Golden Nugget variation on March 29, 1915. These buds were propagated on sour orange seedling rootstocks in a commercial nursery in cooperation with the Citrus Experiment Station of the University of California, and the resulting trees were transplanted to the progeny orchard of the Citrus Experiment Station at Riverside, Calif., in July, 1917.

The parent tree of progeny trees 5, 6, 7, 8, 9, 10 and 11 was a Thomson strain tree in a Washington orchard. In this tree there occurred two limbs bearing Golden Nugget fruits and the remaining branches produced typical Thomson fruits. Budwood was secured from each of the two Golden Nugget limb variations and from one of the Thomson branches on the same tree on February 11, 1916. They were inserted on sour orange seedling rootstocks in a commercial nursery in cooperation with the Citrus Experiment Station of the University of California. The resulting trees were transplanted to the progeny orchard of the Citrus Experiment Statio nat Riverside, Calif., in May, 1919.

All the progeny trees have made a normal growth and those numbered 1, 2, 3, and 4 produced their first crops of fruit during the season of 1920-21. The other progeny trees bore their first fruit during the season of 1922-23.

No fertilizer has been used in maintaining this orchard until the spring of 1924. Winter and summer cover crops have been grown each year and plowed under for soil improvement purposes. The trees were set out in rows 24 feet apart, and the individual trees were planted 10 feet apart in the row. This close spacing permits of the testing of a larger number of trees than would be possible with wider spacing of the trees in the row. This arrangement does not provide the environmental conditions essential for a maximum yield, but the conditions are uniform for all of the trees. In this instance the most important feature of the test is the transmission of the strain characteristics of the bud variations as compared with the characteristics of the normal parent strain. The results of this test have been very striking and apparent to all observers.

Progeny Pereformance Records

The results of the progeny tests of the Golden Nugget strain variations and the progeny performance of comparative Thomson strain propagations for the years 1920-21 to 1927-28, inclusive, are shown in Table IV, in which the number of fruits borne by each tree each season with their strain characteristics have been recorded.

It is noteworthy that the progeny tree 4 from a Golden Nugget tree

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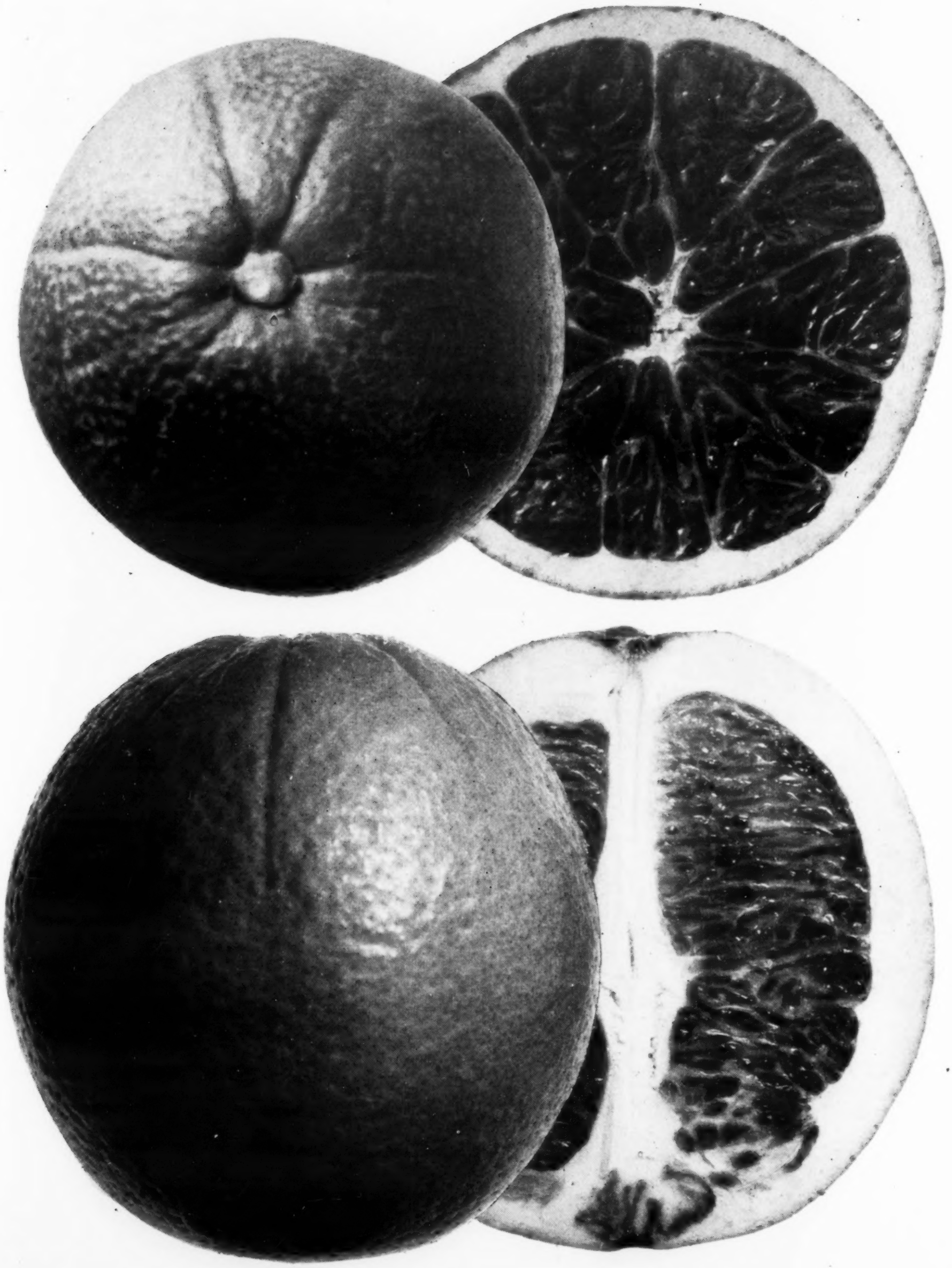

FRUITS OF GOLDEN NUGGET STRAIN

Figure 7

(Above) fruits of the Golden Nugget strain of the Washington Navel Orange produced by a limb variation; and (below) from progeny tree No. 2 listed in Table IV which was propagated from that limb variation.

variation produced a total of 1,204 Golden Nugget fruits during the performance record period. All of these fruits have been typical of the Golden Nugget strain and the large production indicates that this tree may prove to have unusually high yielding characteristics, in marked contrast to the other trees of this strain.

Not only have the fruits of the Golden Nugget progeny trees been typical of this strain but the habit of growth, color and shape of leaves and other foliage characteristics of these trees are clearly typical of the Golden Nugget strain. There is no doubt that the characterisics of the bud variations have been transmitted through bud propagation.

Conclusion

The progeny tests recorded in the foregoing paragraphs prove that the characteristics of the two bud sports, Yellow and Golden Nugget have been transmitted through budding. These results indicate that the origin of the Yellow and Golden Nugget trees in established orchards has been through the accidental or intentional propagation of limb variations of this nature.

The yellow color of the fruits of these strains is less desirable from the market standpoint than the orange or reddish-orange color of the fruits of the parent strains. For this reason the crops from the trees of these strains are of less commercial value than are those from the parent strains.

The lower yields of the trees of the Golden Nugget and Yellow strains as compared with those of the parent strains demonstrate that trees of the Yellow strains and some of those of the Golden Nugget are inherently less productive than those of the normal strains.

The results of these tests show in a striking manner the importance of bud selection in the propagation of the Washington Navel orange in order to avoid the perpetuation of undesirable strains which produce light crops or fruits of inferior quality.

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TABLE I—Records of annual production of progeny trees propagated in 1915 from limb variations of the Yellow Thomson strain in five different trees and from normal Thomson portions of four of the same parent trees. All of the fruits borne by these trees have been typical of the strains that were propagated, with the exceptions noted below.

Strain	Tree No.	Numberof fruits produced each season[1] 1920-21	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	Totals
Progeny of Yellow Thomson limb in tree 15-9-6	1	6	88	70	258	183	257	296	319	1,477
	2	40	116	53	183	108	142	171	155	968
Progeny of normal Thomson limb in same parent tree as 1 and 2	3	1	75	94	258	173	150	292	126	1,169
	4	18	115	121	511	334	270	380	122	1,871
	5	22	39	74	453	325	268[1]	405	230	1,816
Progeny of Yellow Thomson limb in teh 14-5-8	6	18	52	34	82	32	50	152	55	475
	7	6	47	25	148	75	133	230	179	843
Progeny of Yellow Thomson limb in tree 14-23-9	8	45	151	62	263	140	232	396	170	1,459
	9	21	50	26	110	33	98	163	53	554
Progeny of normal Thomson limb in same parent tree as 8 and 9	10	33	136	63	191	208	190	341	231	1,393
	11	15	28	55	177	45	103[1]	308	182	913
Progeny of Yellow Thomson limb in tree 4-3-18	12	30	75	36	97	35	92	151	57	573
	13	28	72	43	126	26	122	194	154	765
Progeny of normal Thomson limb in same parent tree as 12 and 13	14	30	198	112	374	277	255	505	233	1,984
	15	23	177	44	184	198[1]	172	345	215	1,358
Progeny of Yellow Thomson limb in tree 1-25-4	16	18	48	67	354	127	278	594	280	1,766
	17	10	61	43[2]	168	41	51	249	191	814
Progeny of normal Thomson limb in samep parent tree as 16 and 17	18	1	47	105	258[3]	80	238[4]	599	198	1,526
	19	17	103	121	249	117	147	306	159	1,219

Average total production of ten progeny trees of the Yellow strain ..... 969 fruits
Average total production of nine progeny trees of the normal Thomson strain ..... 1,472 fruits

[1]Including one fruit with yellow sections.
[2]Including one fruit of the Washington strain.
[3]Including four fruits with yellow sections.
[4]Including one fruit of the Yellow Thomson strain and three with yellow sections.

TABLE II—Records of annual production of progeny trees propagated in 1916 from four different trees of the Yellow Washington strain which were found with several other similar trees in a grove that was supposed to be entirely of the Washington strain of the Washington Navel Orange. Production records of four progeny trees of the Washington strain that were propagated and planted in May, 1919, at the same time as the Yellow Washington trees are included for comparison. All of the fruits borne by these trees have been typical of the strains that were propagated with the exceptions noted below.

Strain	Tree No.	Numberof fruits produced each season[1] 1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	Totals
Progeny of Yellow Washington tree 6-2	1	0	25[1]	75	82	225	201	85	693
	2	0	53	67	80	192	203[1]	55	650
	3	2	14	43	105	250	269	90	773
Progeny of Yellow Washington tree 6-6	4	0	17	62	120	188	279	87	757
	5	2	26	51	148	123	255	63	658
Progeny of Yellow Washington tree 9-3	6	0	32	23	15	69	155[2]	13	307
	7	0	20	14	19	125	228	21	407
Progeny of Yellow Washington tree 4-2	8	4	26	67	105	102	210[2]	99	613
	9	0	25	80	158	108	186[2]	61	618
Progeny of normal Washington tree 25-2	10	3	11	43	129	206	264	33	689
	11	2	17	58	144	221	300	129	871
	12	0	38	50	112	144	171	56	573
	13	2	29	64	148	228	306	125	900

Average total production of nine progeny trees of the Yellow strain ..... 608 fruits
Average total production of four progeny trees of the Washington strain ..... 758 fruits

[1]Including two fruits of the Washington strain. [2]including four fruits with Washington sections.

TABLE III—Records of annual production of trees of the Yellow strain which were top-worked from a limb variation of this character and included in an investigation plat of Washington Navel oranges where performance records were secured for four seasons. All of the fruits borne by these trees were typical of the yellow Washington strain with the exceptions noted below. Total yields of 13 comparable normal Washington trees are also given.

Tree Number	Number of fruits produced 1911-12	1912-13	1913-14	1914-15	Totals	Totals for 13 Washington Trees
3-25-16	78	146	528	199	951	1,731
3-25-18	277	128	304	338	1,047	1,747
3-26-17	374	226	495	412	1,507	1,610
3-27-20	465	334	559[1]	217	1,575	2,036
3-28-19	453	345	520[2]	219	1,537	1,764
3-29-21	309	195	372	249	1,125	2,374
3-30-16	224	212	325	246	1,007	1,198
3-31-16	384	196	355	319	1,254	1,665
3-31-18	171	111	399[1]	388	1,069	2,169
3-31-19	400	183	311	355[1]	1,249	1,369
3-32-15	156	67	207	113[1]	543	1,745
3-32-17	176	123	268	243	810	2,231
3-32-20	131	104	215[1]	178[1]	628	1,820
Totals	3,598	2,370	4,858	3,476	14,302	23,459
Average per tree	277	182	373	267	1,100	
Average for 13 Comparable Washington trees	479	296	679	350		1,805

[1]Includes 1 fruit showing a section of normal Washington rind.
[2]Includes 3 fruits showing sections of normal Washington rind.

TABLE IV—Records of annual production of progeny trees propagated from limb and tree variations of the Golden Nugget strain of the Washington Navel orange and similar records of progeny trees propagated from normal portions of two of the same parent Thomson trees. All of the fruits produced by these progeny trees have been typical of the strain which was propagated.

Strain	Tree No.	Numberof fruits produced each season[1] 1920-21	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	Totals
Golden Nugget rfom limb variation in tree 5-21-1	1	20	66	45	147	75	92	217	61	723
	2	15	24	44	202	96	122	160	34	697
Thomson from normal part of tree 5-21-1	3	3	38	47	227	103	153	231	109	917
Golden Nuggett from tree variation 5-17-23	4	22	14	35	279	168	207	319	160	1,204
Golden Nugget from limb variation in tree 24-2	5	—	—	5	65	169	112	137	49	537
	6	—	—	4	30	158	133	175	81	581
Golden Nugget from 2nd limb variation in tree 24-2	7	—	1	3	50	123	76	239	30	522
	8	—	—	7	48	126	55	159	44	439
Thomson from normal part of tree 24-2	9	—	2	12	68	168	121	215	203	789
	10	—	3	13	34	149	153	312	145	809
	11	—	8	24	151	193	208	342	?65	1,091

[1]Trees 1 to 4 inclusive were planted in July, 1917. Trees 5 to 11 inclusive were planted in May, 1919.